Design Engineering

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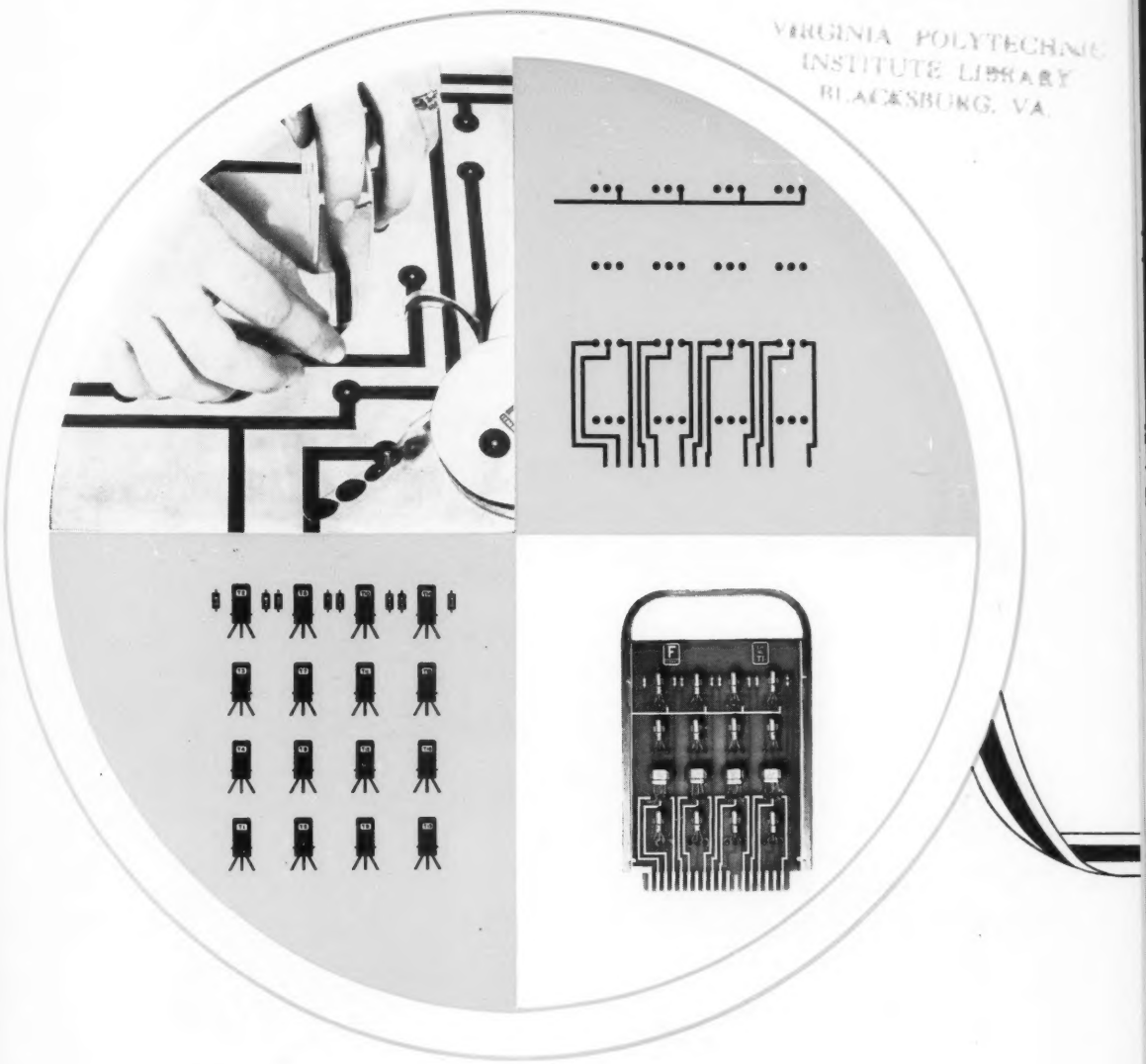


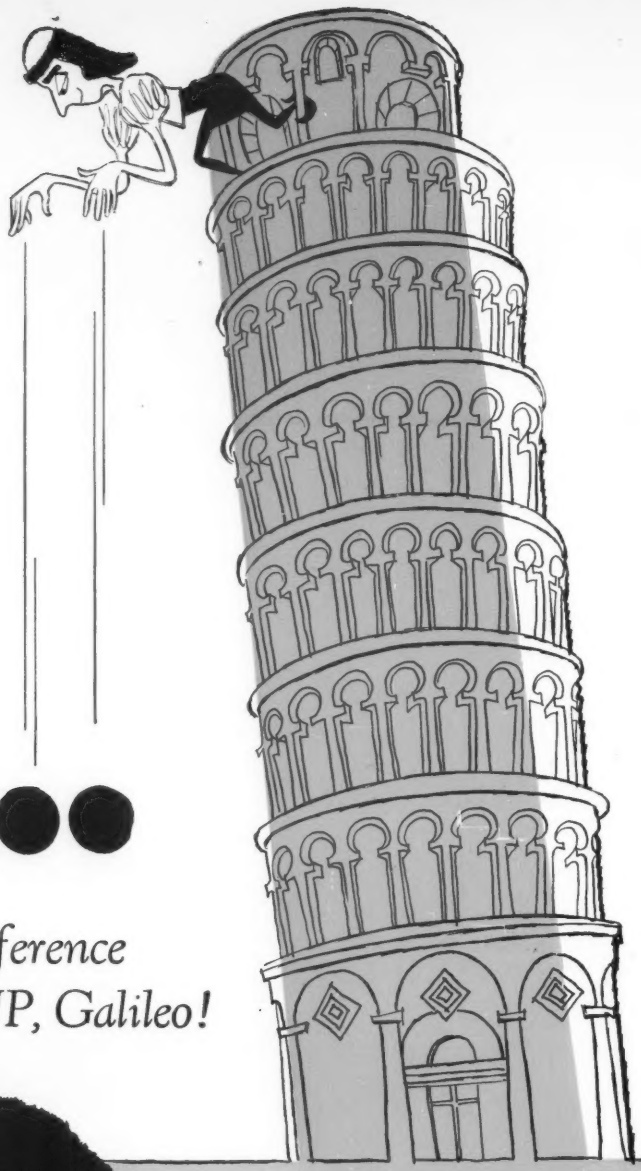
DESIGN FOR ECONOMY THE MODULAR WAY **(page 44)**

Turn night into day with infra-red rays

First man-made heart is Canadian

May 1956

PUBLISHED BY MACLEAN-HUNTER PUBLISHING COMPANY, LIMITED, TORONTO, CANADA



. . . there's a difference going UP, Galileo!

GOING DOWN, bodies of different weights fall at the SAME speeds. The great Galileo spectacularly proved his theory over 350 years ago — dropping weights from the Leaning Tower in his native City of Pisa.

. . . *but going up* is altogether different — as the world of modern manufacturing and building appreciates.

The amazingly light weight of today's tough aluminum alloys, for example, makes possible speedier installation, cuts labor and shipping costs. Only one-third the weight of ordinary metals, strong, corrosion-resistant aluminum in ductwork, roofing and siding, and other applications — *goes up faster;* then lasts a lifetime!

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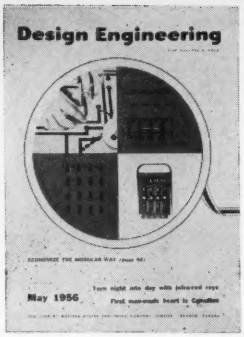

Design Engineering

VOL. 2 MAY 1956 NO. 5

This month's cover

This month's cover by artist Des English has the roll of tape used for dimensionless drawing as the cradle for the pictorial interpretation of Modular Design. How the tape is used is shown in the upper left area. Beside it is a blueprint of its arrangement.

Lower left are the circuit variations for a computer's interconnected gate package, lower right. From these spidery amoeba-like modules and the railway-fashioned blueprint of the dimensionless technique, scientists are laying bricks electronically.

Design Engineering

MEMBER

CCAB

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Avro's CF-100 all-weather, night and day, rocket-firing twin jet interceptor is an example of what this engineering team has done. In coast-to-coast service with the R.C.A.F. in Canada and also scheduled for NATO in Europe later this year, the CF-100 is only the beginning. Under development are concepts representing the most advanced state of the art.

You can be a useful member of Avro's progressive design team—enjoy satisfaction and experience in the most advanced phases of aviation.

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Editorial correspondents in: The United Kingdom, the United States, Germany, France and Italy.

The **June** issue of **Design Engineering** will carry strong feature articles written by contributors no less experienced than those featured this month.

Tormag Drives will be our lead feature for June, another well researched article, which tells about a method of torque transmission being developed in Canada.

And explosive Rivets — interesting to all engineers at the design level — will also be fully covered in next month's issue.

Special Artwork

Editorial layouts designed by art consultant **Desmond English.**

David Nuttall

David Nuttall, who wrote Modular Design (page 44), went directly to Ferranti as an electronic engineer after he graduated from British Columbia University with a B.A.Sc. in 1949. For the past two years he has been in the product engineering group of the company's research division. Deeply involved in modular design and mechanized processing, assembly and inspection equipment projects related to computer components.

Robert Groves

Employed by the British War Office before he came to Canada in 1953, Robert Groves who produced the interesting Infra Red Ray story (page 29) is an engineer in the electronic equipment and tube department of Canadian General Electric. He is currently engaged in market research and export sales studies. Serving with the Royal Ordnance Corps and REME during the last war, he worked on fire control and search radar as well as V2 detection.

Kenneth Renz

Kenneth Renz is a native of Huntingdon, Ind. He attended Indiana and Purdue universities and was then hired by the Asbestos Manufacturing Company, an affiliate of Thermoloid located in his home town. Working first in sales engineering and then in sales management, he was promoted after nine years to assistant sales manager of the manufacturers sales division of the company. It is with this accumulated "know-how" that he wrote the article on Friction Materials (page 48).

Brian Cahill

Author of the Heart (page 41), Brian Cahill is a staff reporter for the Montreal Gazette who covers many stories dealing with science and medicine. Born in Newfoundland, he went to private school there and held a variety of jobs following graduation from bell-hop to seaman. In 1942 he joined the St. John's Daily News and was successively reporter, deskman, feature writer and proofreader. Turned down for military service because of his eyes, he was hired by the Gazette in 1943. He has been with the newspaper since with the exception of two years in public relations. In his mid-thirties, writer Cahill is married with one child.

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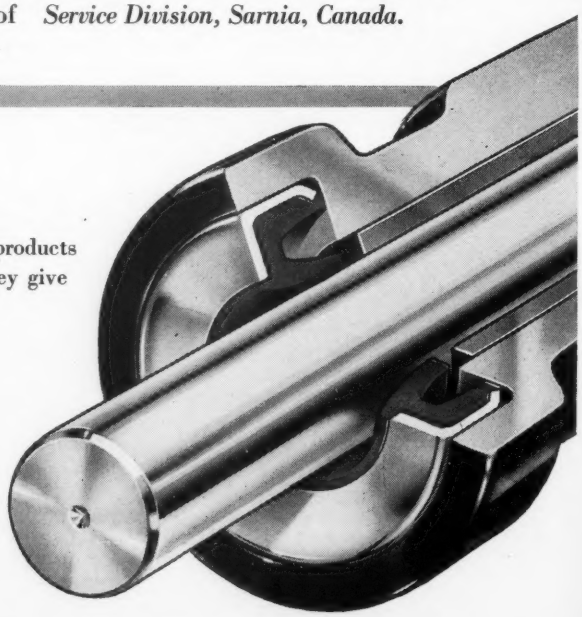

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Reports

Motorola TV (tune) out-of-tune in Chicago

TORONTO—A decision (dictated mainly by the U. S. parent company) has started the shutdown of MOTOROLA CANADA LTD. which has been in business here since 1952.

Vice-president and general manager of Canadian operations, Virden E. Scranton, told Design Engineering that basically the decision was made in Chicago.

"It is in the best interests of Motorola (U. S.) to carry out the U. S. expansion program, particularly in color TV, by curtailing manufacture here," he said.

Conceivably, he added, radio and television sets will be exported from the U. S. into Canada when the final close-up comes in the fall.

In 1952 when Motorola entered Canada the firm occupied between 35 and 40,000 sq. ft. Today as the company plans to leave, that area has grown to 100,000 sq. ft.

Asked how many consumer units of radio, TV, etc. were produced in the current year, American Scranton declined to answer.

The company, he said, would continue to market the products available until next fall.

"Some engineers of the 25 or 30 we have will likely go to the U. S.," he went on.

Pressed as to exactly how many engineers this country would lose to the U. S. company, he said: "Not more than three or four technical people will go."

Motorola (U. S.) will continue to license the Canadian Radio Corp. here to make two-way mobile radios, radar and micro-wave relays.

Supreme authority in Chicago only knows how long or how short this arrangement might be since the augmented voice of agency and executive express an abiding "no comment."

• • •

Aero division takes control

LEASIDE, ONTARIO — Two newly formed divisions of the MINNEAPOLIS-HONEYWELL REGULATOR CO. LTD., Ordnance and Doelcam, will be controlled by the company's Aero division here.

"In the U. S. all three divisions are under separate control since the size of each division prevents an easy integration," explained Canadian Aero Division manager, Carl A. Anderson.

The company is already hiring personnel for the new divisions. A director of engineering—a Canadian who has been employed by the parent company in Minneapolis—will supervise the engineering aspect of the united divisions whose total floor area at present is 10,000 sq. ft.

"Within a year this will be expanded to 40,000 sq. ft. we expect," said Manager Anderson.

Activities of the 2-month-old divisions will include the design and development of weapons systems and electro-mechanical instruments similar to those developed by the parent firm in the U. S.

The new design team slated to do this work, DESIGN ENGINEERING learned, will comprise in 6 months about four sales engineers, 10 field service engineers and a director of engineering who is a Canadian now employed with the firm.

The Ordnance and Doelcam divisions were set up during wartime in the U. S. as units removed from the aero operations but nonetheless related to them since the same employees often worked on aircraft projects, too.

Stabilized platforms, electrically operated, built for tanks, and proximity fuses have been made by the two divisions.

Employees, trained in minute assembly of "clock-like" precision with exacting tolerances, are a natural group to associate with gyro-type projects.

• • •

Canadian electronics filmed

TORONTO—An expanding public relations program has been instituted by the two-year-old RADIO-ELECTRONICS-TELEVISION MANUFACTURERS ASSOCIATION (RETMA). One of the steps taken in the Association's new look has been the production of a half-hour film about Canada's electronics industries.

A résumé of Canadian achievements in the past 35 years of electronics developments, the well-edited sound-color motion picture is titled, "Electronics in Canada." It was made by Cinesound Ltd., a Canadian company, for the RETMA.

"The reason we have brought out the movie," explained Association President Carl A. Pollock, "is to broaden our PR work and keep in tune with our rapidly advancing electronics industry, which I believe basically offers more to Canada than any other industry in this country."

The picture will be available, he added, to educational institutions and service organizations, in fact any group that is interested in building interest among young people who might make a career in electronics.

Co-ordinated preparation of material for the film by the 116 members of RETMA has resulted in a film that amply shows the build-up of the industry which now employs over 25,000 production workers, scientists and engineers. Half a billion dollars in electronics goods and services are produced in one year.

Although the RETMA has existed only since 1955, it is the outgrowth of the original Radio-Television Manufacturers Association (RTMA), which was organized in 1952. An earlier association paralleling it started in 1929 and was known as the Radio Manufacturers Association.

"Of 30-odd companies in 1929," President Pollock recalls, "we dropped to 11 or 12 up until the start of the second war."

He blamed the decline in the number of radio companies in the 1930s on two things: keen competition—depression.

"During the war years electronics here boomed in our industrial, military and commercial activities—the boom is still on," he smiled.

RETMA makes a movie on electronics in Canada.

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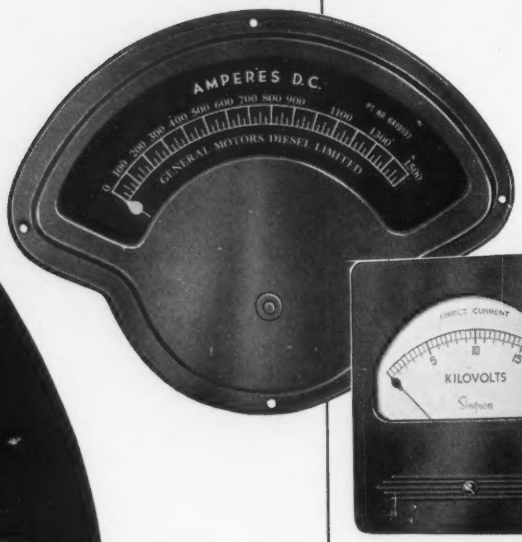

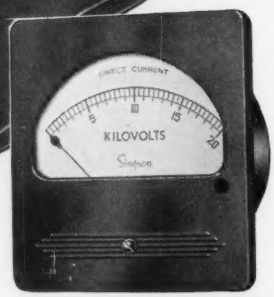

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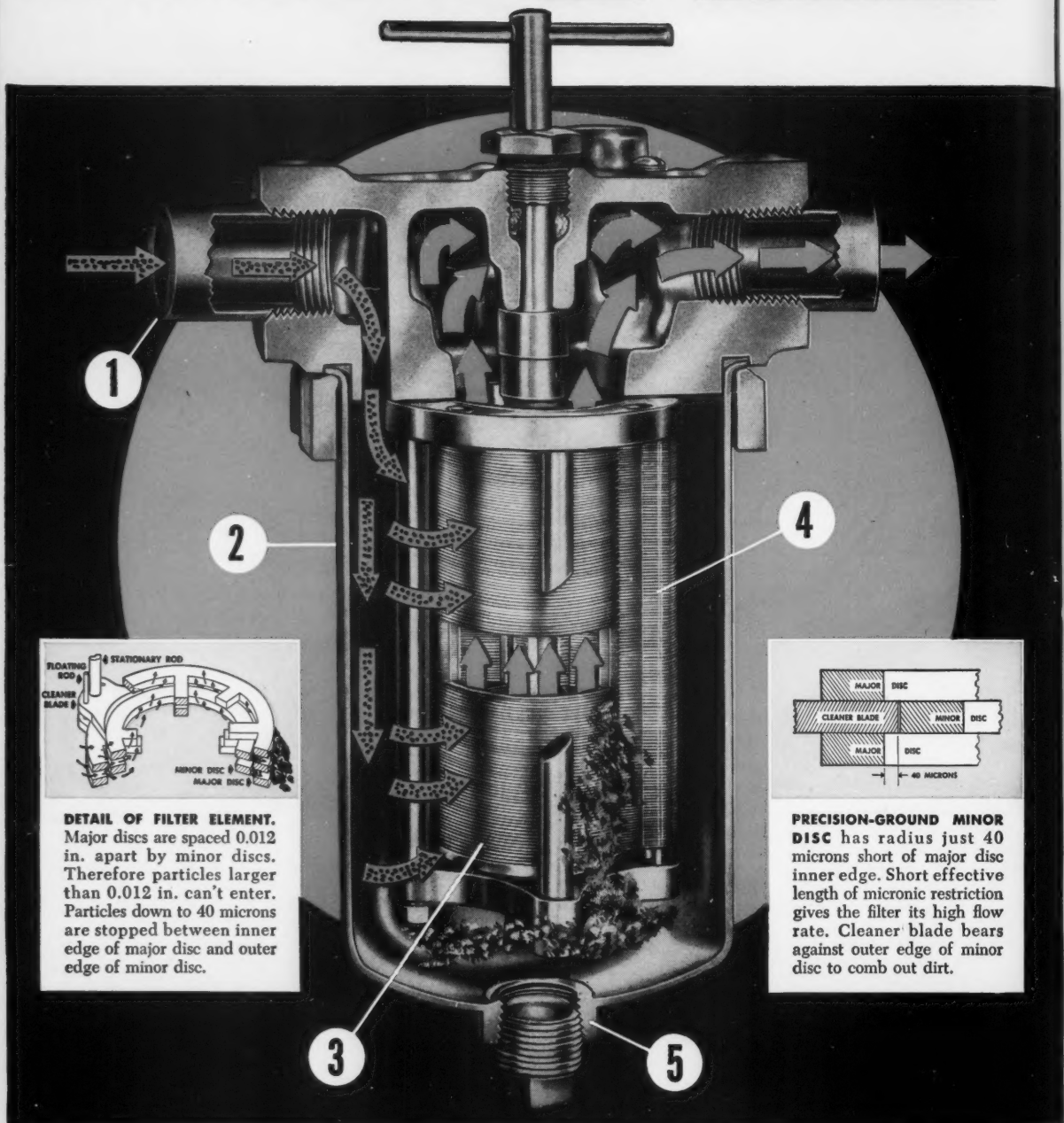


DETAIL OF FILTER ELEMENT. Major discs are spaced 0.012 in. apart by minor discs. Therefore particles larger than 0.012 in. can't enter. Particles down to 40 microns are stopped between inner edge of major disc and outer edge of minor disc.

PRECISION-GROUND MINOR DISC has radius just 40 microns short of major disc inner edge. Short effective length of micronic restriction gives the filter its high flow rate. Cleaner blade bears against outer edge of minor disc to comb out dirt.

CUTAWAY of new SUPER Auto-Klean. Dirty liquid enters inlet (1) at left, fills housing (2) and flows through metal-edge filter (3) of stacked major and minor discs. Trapped dirt is combed out by cleaner blades (4) when discs are rotated and is removed through drain (5). Clean liquid rises through center of filter element, leaves at right.

self-cleaning filter!

The SUPER Auto-Klean for lube, hydraulic fluid, coolant, fuel and other liquids

. . . and you can clean this filter by simply turning the handle!

Many times smaller than other micronic filters of equal capacity, Cuno's new SUPER Auto-Klean filter now makes possible economical, compact, micronic filtration at high flow rates and eliminates the need for replacement cartridges. On machine tools and industrial machinery, SUPER Auto-Klean gives micronic filtration of lubricating oil, hydraulic fluids, coolants, fuels and other liquids. Here's what it offers:

1. Full-flow micronic filtering with a self-cleaning filter. Filter can be cleaned continuously with motor drive or intermittently by manually turning handle.

2. Eliminates cartridge changes. Ends operating costs if you've been using cartridge filters.

3. No pressure drop build-up. An 8-in. long, 2½-in. diameter cartridge handles 30 gpm of oil of 200 SSU viscosity with only 3 psi pressure drop—up to 75% more with slightly higher pressure drop.

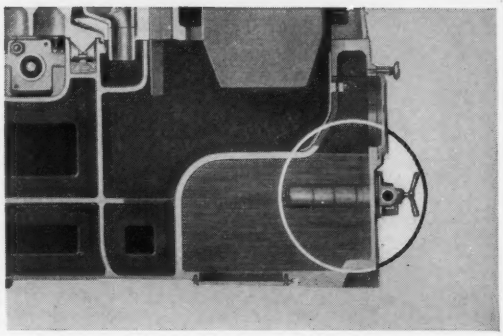
4. Positive protection against particles larger than 40 microns (actually 0.0015 in.). Filter can't rupture or channel.

5. Much smaller than replaceable-cartridge-type filters of equal capacity. It saves with lower initial costs, lower installation costs, requires less space than cartridge units. You get high capacity in a small package.

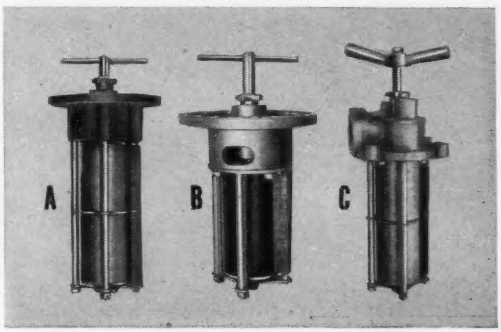
6. No duplex units needed. Handles full flow all the time with no interruptions for cleaning.

7. SUPER Auto-Klean fits existing Auto-Klean housings. You can easily replace most 2¾-in. diameter cartridges with SUPER Auto-Klean for finer filtration.

Send coupon for complete information on the new SUPER Auto-Klean filter, for your new designs or existing equipment. Peacock Brothers Limited, P.O. Box 1040, Montreal 3, Que.



WILL IT FIT? Here's how one designer answered that question. Filter *(circled)* mounts horizontally in side wall of hydraulic fluid reservoir in this surface grinder.



FILTERS FOR INTERNAL PIPING *(A and B above)* allow streamlined design plus the best in filtration. Flange mounting with external outlet *(C above)* and line-type *(cutaway on facing page)* are just two of many other possibilities.

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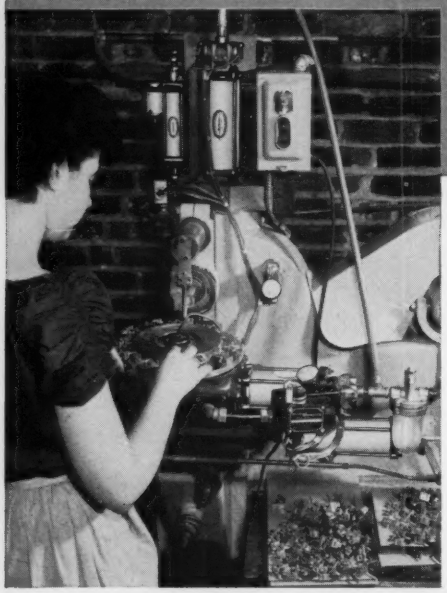
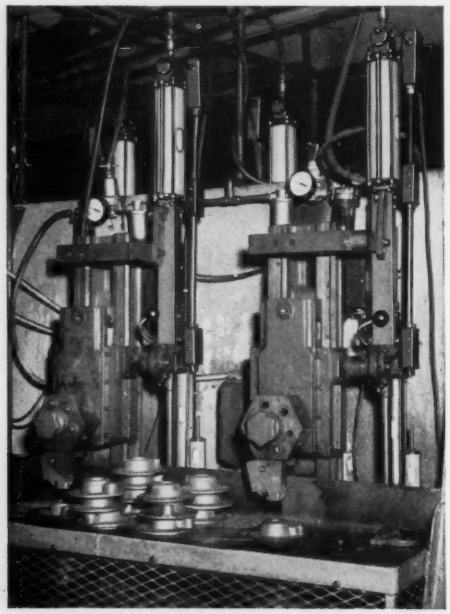
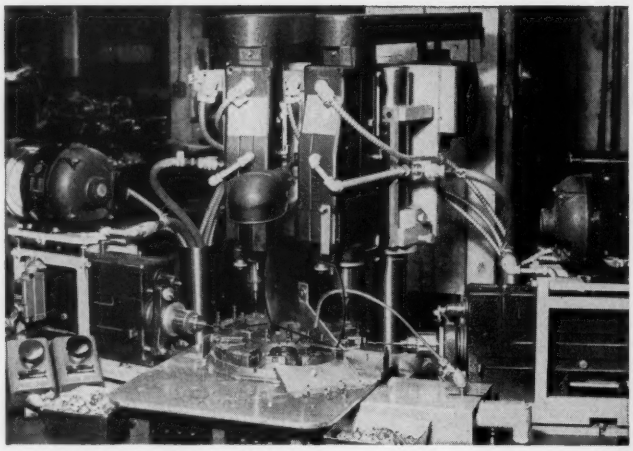


This semi-automatic set-up at Eastman Manufacturing Co. doubled production and eliminated fatigue in milling bakelite magneto parts.



A simple installation cut lathe time on steel ordnance parts from 90 to 10 seconds per piece at Joseph Pickard's Sons of Philadelphia.

you can build cost-cutting special machines or modernize existing machines right in your own shop with your own personnel



This drilling machine, built by Horrocks-Ibbotson, turned out 1 year's production of their fishing reel pawl blocks in 3 months.

Even for short runs you'll find special machines built around this versatile power unit will pay off in a big way — in greatly lowered costs, in fewer rejects, in better product quality. No expensive engineering is needed. In fact, your local Bellows Field Engineer may have in his Foto-Facts File basic designs that can be readily adapted to your product and your production processes.

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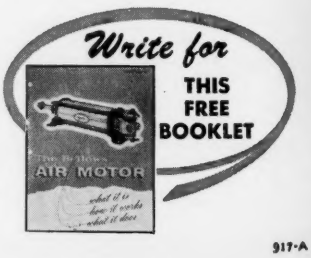

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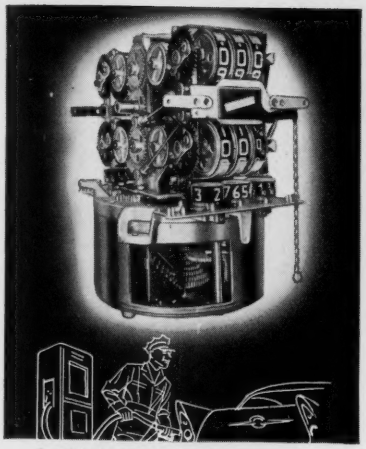
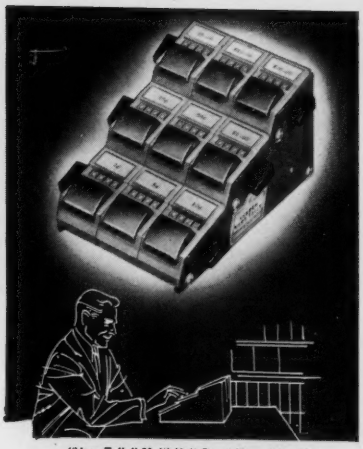
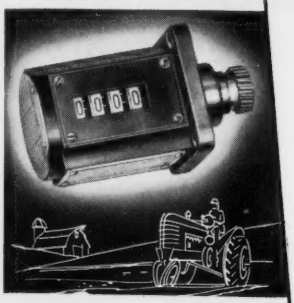


Computing Head for Gasoline Pumps

"Master Meter Duplicator" prints receipts for fuel oil delivered from trucks



"Vary-Tally" Multi-Unit Reset Manual Counter



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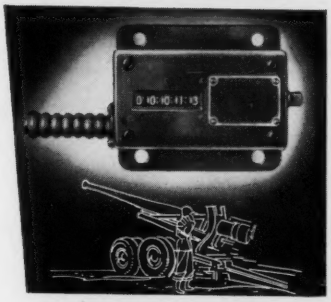

Recoil Counter for new 280 mm atomic cannon

2-3-4 Convertible Counters (and others) for textile machinery

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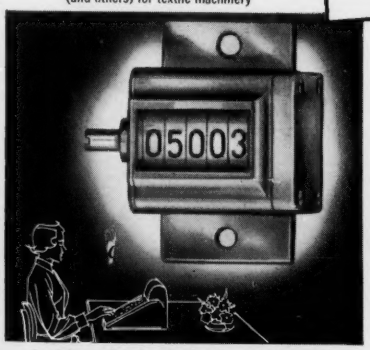
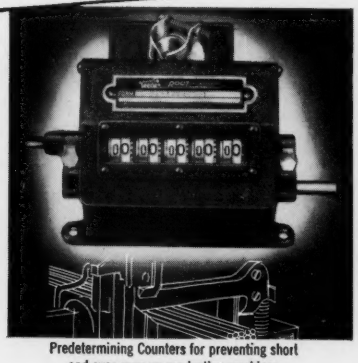
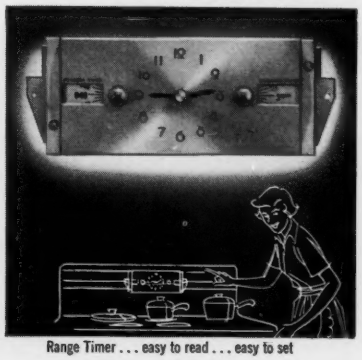


Small Square-Case Counters for office and other machines



Predetermining Counters for preventing short and over-runs on production machines



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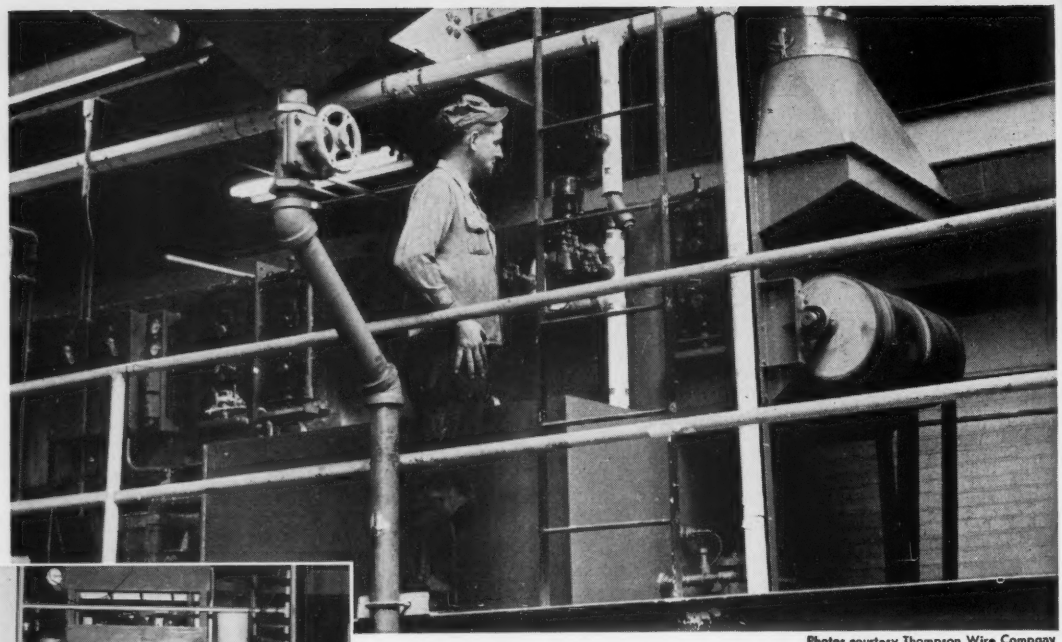
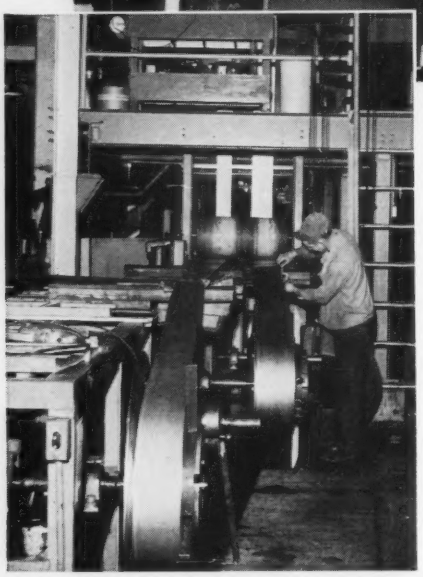
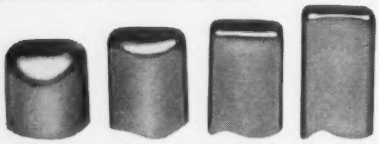


Photos courtesy Thompson Wire Company



Above (right)—In this continuous installation, strip steel is treated with Bonderite, then with Bonderlube lubricant. *Below*, treated strip is re-coiled as it comes out of the machine, Bonderite-Bonderlube treated.



Successive steps in forming a small case from Bonderite and Bonderlube treated strip.

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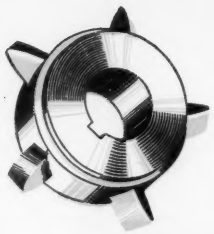

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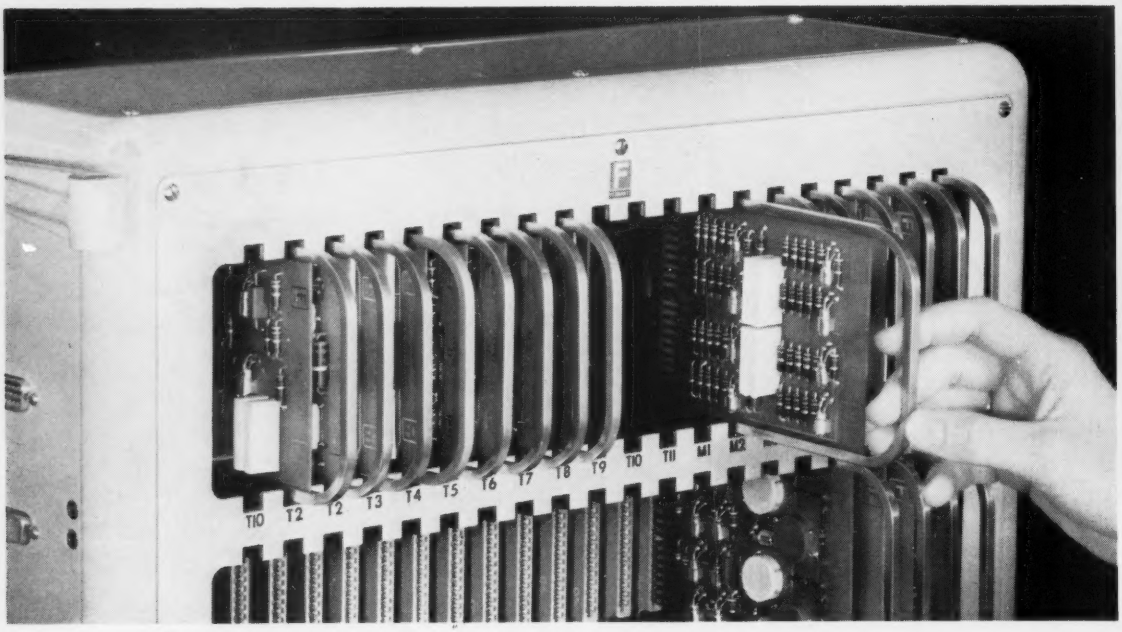

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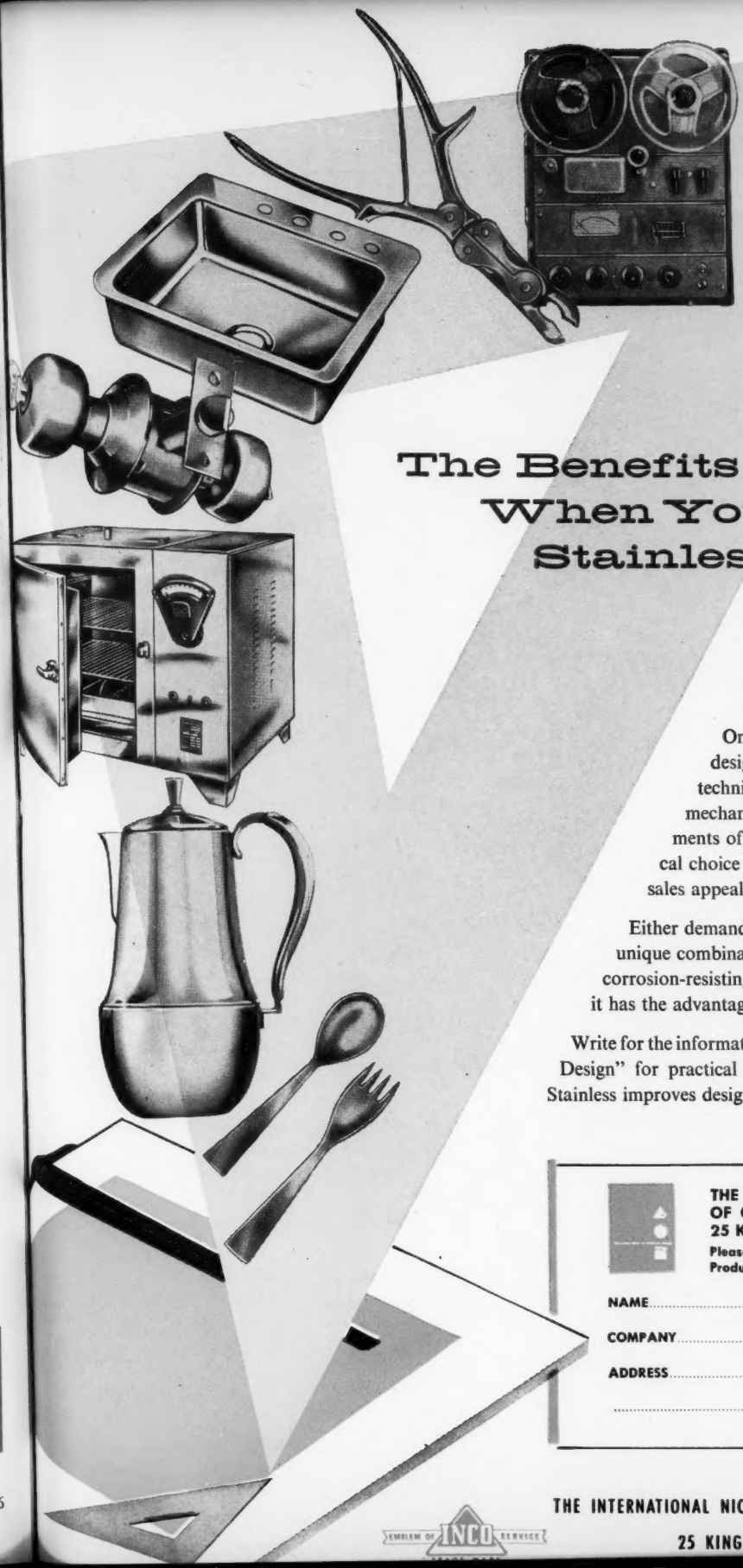

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5. **Can eliminate mechanical timers.**
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8. **Will reduce cost, size and weight of products and processes.**
9. **They last indefinitely — need no maintenance.**

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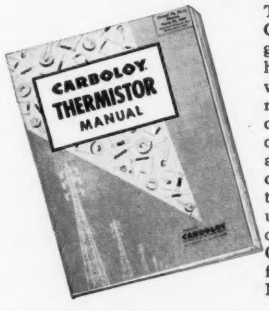

This free technical book, Carboloy Thermistor Manual, gives extensive information helpful to persons concerned with the design or improvement of products and processes. It includes basic circuits and performance curves, and "idea" circuits, with curves, are provided as a guide to the best utilization of the unusual operating and physical characteristics of G-E Carboloy Thermistors. Write for this 56-page manual today. Mail the coupon below.

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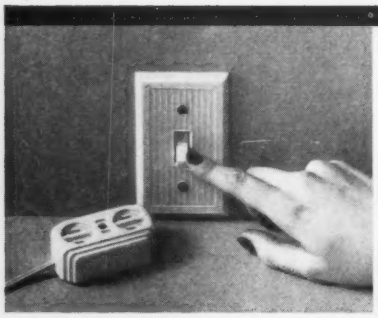

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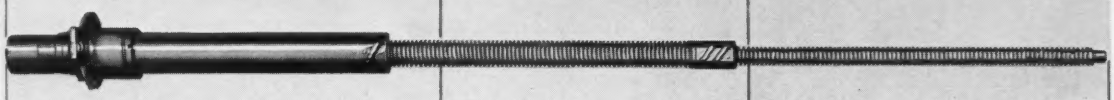

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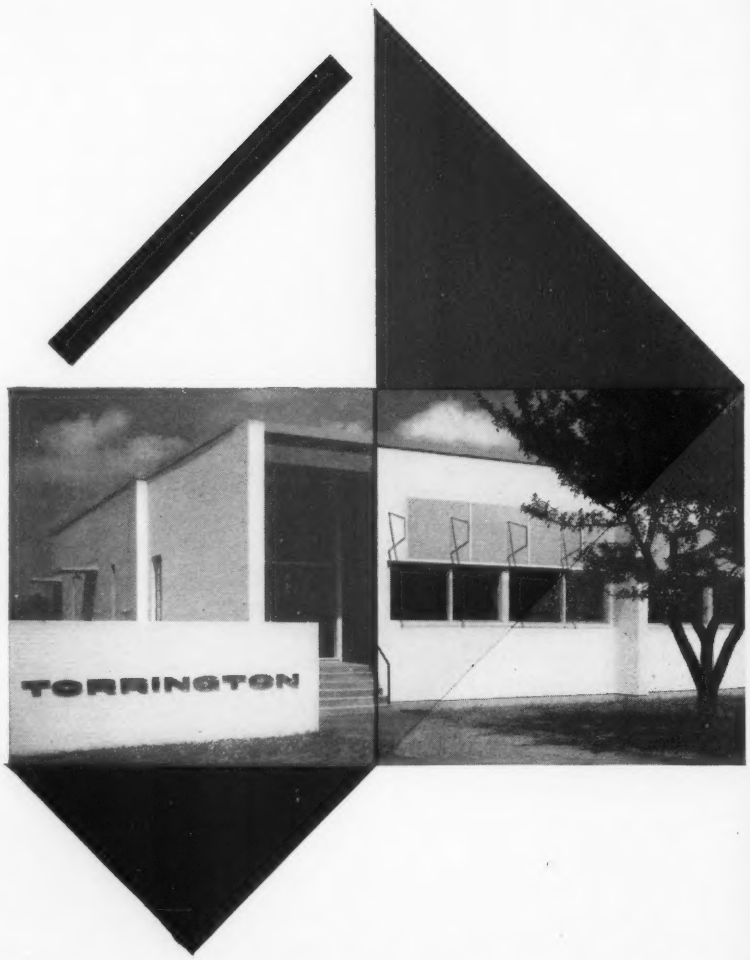

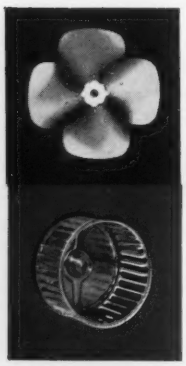

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VIP's

Atom expert — "Canadian future is big"

A "BIG" FUTURE exists for Canada in the field of atomic energy the newly appointed secretary of Atomic Energy of Canada, DONALD WATSON, reports from his Ottawa office.

"We know that we can get energy from the atom at a price," he continued, "but right now the price is high."

The cost will be reduced progressively, he said, as the expense of producing nuclear power is now at its zenith.

Hydro power will, in fact, physicist Watson affirmed, become more costly to produce from now on.

The realm of the atom was not always foremost in the 36-year-old Watson's curricula. Nuclear specialization began for him in 1946 when he came to Canada.

His career previously had been with the Telecommunications Establishment in the U. K. and in India following graduation from Oxford.

Engineer Watson, who has always been an administrator, came to Chalk River as an officer of the U. K. scientific staff.

In 1948 he was put on loan to the (Canadian) National Research Council (NRC) and two years later he severed connections with the U. K. group. Then, in 1952, Atomic Energy of Canada was formed as a successor to the NRC's atomic energy division and administrator Watson became one of its first employees.

How did atomic energy first get under way in Canada?

Scholarly Watson said that several atomic scientists came to Canada as a war measure in the '40s. Most from this group returned to England after the war and pursued their earlier work.

"Canada's interest in atomic energy grew rapidly with a proportionate number of our scientists entering the atomic field as other research," he observes.

What about specific education for the atomic engineer?

Ottawa University, he said, is planning a one-year graduate course in nuclear engineering starting this autumn.

Atomic power and atomic specialists are only the core in secretary Watson's opinion of the atomic-tomorrow.

"It is important that we also take time to educate the manufacturers who will be using the new power, and the men who will service products that are nuclear-driven," he emphasized.

Summarizing the outlook for atomic energy in Canada, he quipped, "Atomic power is here to stay as they say in the old cliche— ." And more seriously, "It is something mankind essentially needs as oil, coal and hydro power are more difficult to obtain."

Secretary Watson, who will share the Crown company's Ottawa office with president W. J. Bennett is married with two children, Peter seven, and Shirley four.

• • •

Trans-Atlantic TV soon—expert

UNIQUE POSSESSOR of an electronics career that began as a one-year radio engineering stint in China, J. B. KNOX is now general manager of engineering products at RCA Victor Co. Ltd.

Engineer Knox who hop-scotched his way around the world "one jump ahead of the depression" as he describes it, is today closely informed about long-distance TV. In 1951 he was awarded a Fellowship in the Institute of Radio Engineers.

He told DESIGN ENGINEERING from Montreal that later this year there will be experimental telecasts from the southern tip of Florida to Havana, Cuba.

"It is only a question of time before we will have trans-oceanic TV, too," he continued.

The longest single jump by a northern system from Canada to Scotland he said, is from Greenland to Iceland, but it is still within the limits of the approximate 300 mile range of the proposed system. From Iceland the next link will be the Faroe Islands.

"These scatter circuits are now in operation in several places but only experimentally," he advised.

Engineer Knox whose Chinese adventures began in 1929 with the Curtis Wright Corp. returned to Canada in 1930 to further his education academically. In 1933 he went back to China as an employee of a small electronic manufacturing company.

"When I first went to the Orient," 46-year-old Knox reflects, "it took a full day for a telegram to go 200 miles."

At the time he returned, Knox says that advancement was quite noticeable in China.

In 1935 the long trek back to Canada began for him with a year's stop in England where he worked in radio and electronics.

Back to Canada in the Coronation-year of 1937, engineer Knox happily recalls help wanted advertisement instead of the painful breadlines of the depression years.

"In the radio business we even had some choice of jobs," he adds.

Through the next four years, engineer Knox worked for the Department of Transport (DOT) as a communications engineer, planning and building the TCA communications system.

The much-traveled communications pioneer explained that the DOT provides facilities, navigation aids and communications while the air service itself is supplied by Trans-Canada Air Lines, Canadian Pacific Air Lines and other smaller private carriers of passengers and freight.

"I began working for RCA in 1941 and my first job with the company was to work on the design and construction of radio equipment for the Navy.

This operation, General Manager Knox went on, was followed by his design work and installation of the Pacific Communications system on the West coast.

He was promoted to manager of the engineering products division in 1944 and is now general manager in charge of sales, engineering and manufacturing.

ENGINEER KNOX, *left, outlined stepping stones of proposed TV relay set-up across North from Canada to U.K.*

Farm-fresh to you . . .

How polyethylene plastic helps bring fresher food to your table

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The lady may think she is concealed by darkness. But she is warm. This is all "Eva" needs to see her with.

Turn night into day with infra-red

See, or take pictures, through haze and darkness this new way

By Robert Groves

CANADIAN GENERAL ELECTRIC

A new camera that can see in total darkness has been developed in the U.S. This is the Evaporagraph, made by Baird Associates and nicknamed Eva.

It measures infrared radiation and converts it into a picture. Eva's heart is a membrane so thin that it reflects white light as a color—like the familiar oil film on water. It is about 4 micro-in. thick and locates in an evacuated cell between an optical system and a viewer. One side of the membrane is coated with oil. The other side carries a thin coating of a special material which has not been named.

When you point the camera at a hot object (everything above absolute zero has heat) this is what happens:

The optical system gathers infrared radiation and forms an image on the membrane.

The special coating on the membrane absorbs this radiation which then changes the membrane's temperature by the amount of radiation received at each point.

The temperature changes alter the oil thicknesses (locally) on the other side of the membrane.

The many thicknesses of oil reflect white light from

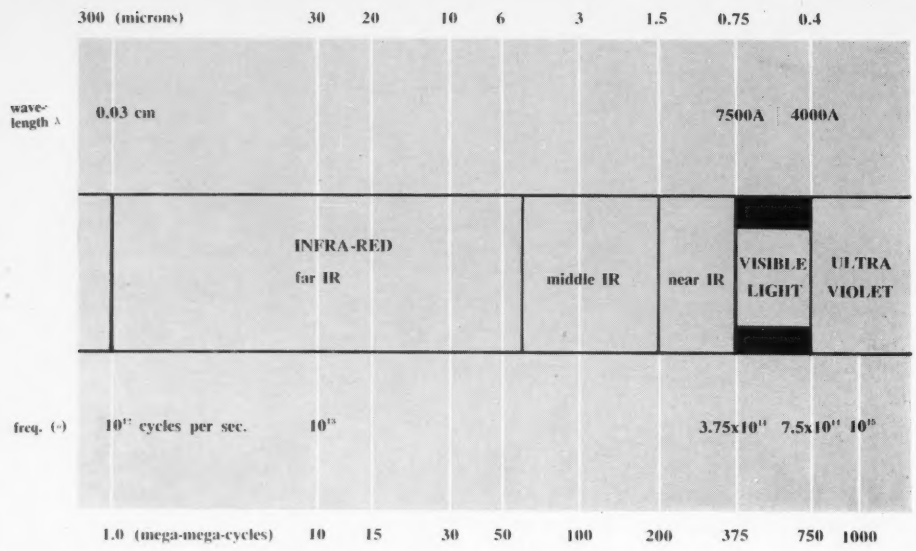
What are infra-red waves?

Infra-red waves occur in the electromagnetic spectrum at frequencies just below visible light, in the range from 1 to 375 mega-megacycles.

They are given out by all bodies at a temperature above absolute zero and travel through space after the manner of radio and visible light waves. They are absorbed by a number of objects, in the process of which the radiation energy is converted into heat energy.

However, the basic concept of infra-red radiation is **not** that of heat waves traveling through the air. Rather is it a surface phenomenon of radiant energy created by molecular thermal agitation.

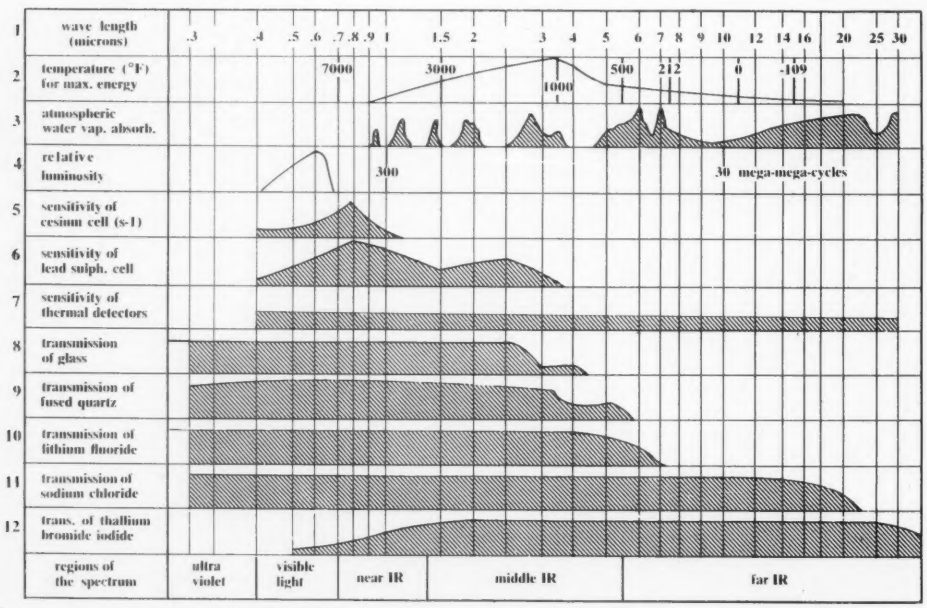
This does not mean that infra-red rays are not used for heating. In some circumstances they most certainly are, as was explained in Design Engineering, August, 1955.



infra-red's place in the spectrum

Diagram 1. *Wavelength and frequency are related by expression* $c = n\lambda$ *where* c *= speed of light.*

Attention is turning more and more to the part of the spectrum we cannot see



How does efficiency vary?

Diagram 2. *Efficient areas are shaded. Glass, for example, works well at .3, falls off at 3.*

Infra-red *(continued)*

the target in different colors. The result is a colored isothermal image which can be photographed.

With Eva's help you can spot a man 200 yards away, or see a house a mile distant in total darkness. With this instrument you can even take a snapshot of heat escaping from a building to give you a check on its insulation weak spots.

The Germans were ahead of the rest of the world for years in infrared experiments. During the war they brought out a night-eye for snipers which they named the Vampire. It was so effective that Montgomery promised two weeks leave to the first company to capture a sample. The Vampire was an infrared viewer mounted on a carbine and using a tungsten filter. The tube was powered at 10,000 volts by an ingeniously arranged battery pile.

Other, larger equipment was used by the Germans for anti-aircraft work and for tank and ship tracing at night. The advantage it gave them was immense. Not only was manoeuvre and pursuit simplified but full-scale engagements could be made much more deadly. Particularly heavy damage was done to Russian tank forces with the help of infrared eyes. Besides this, aircraft could be tracked in flight from the exhaust gas heat they gave off; and ships could be detected up to 25 miles away.

The infrared part of the spectrum lies between 1 and 375 mega-mega-cycles.

It is because this frequency is easily absorbed by many objects and converted into heat that Eva, and other like devices became possible.

This has led to a great deal of misunderstanding. Infrared radiation is not heat waves travelling through the atmosphere. It is a surface phenomenon of radiant energy created by molecular thermal agitation. It travels through space in the same manner as radio or light waves. It is distinguished only by its ability to be converted into heat when it reaches a suitable object.

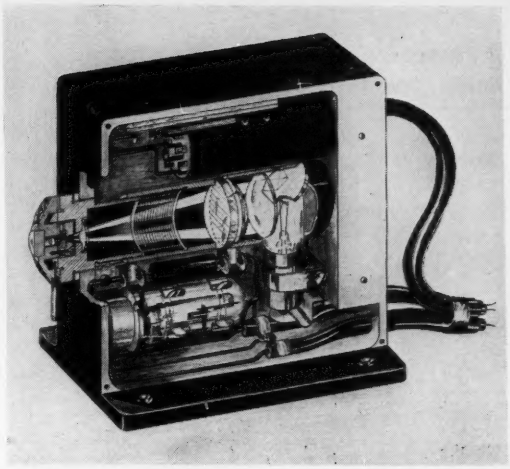
Diagram 1 relates infrared radiations to the rest of the electromagnetic spectrum. Note what a large range they cover compared with the small band of visible light frequencies.

The diagram shows a relationship between frequency, temperature and the water vapour absorption factor shown in lines 1, 2 and 3. It is the absorption factor which must be applied to the spectrum to decide which part of it to use for detection. Note that at the frequencies shown by the peaks in line 3 there is a percentage absorption (or attenuation) of the radiation from the object being sighted. This percentage goes as high as 60 at 6 and 7 microns. Then it drops to about 1% at between 9 and 10 microns rising steeply again to 40% attenuation—but with a sudden dip to about 10% at 25 microns. Attenuation by precipitation in the radar frequencies also is important when it comes to selecting a suitable wavelength.

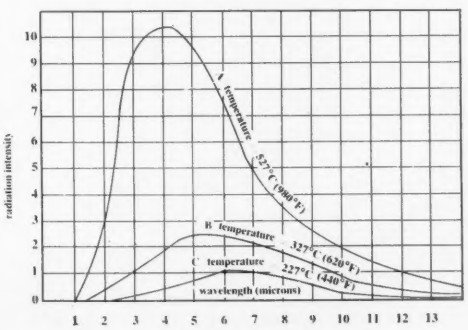
Useful infrared rays come in wave lengths of from 1 to 20 microns—see diagram 2. The basic parameters are contained in lines 1-3. So, if you wanted to detect something with the temperature of a man, peak radiations would occur at around 9 microns. Refer to line 3 and you see a gap in the absorption ranges which makes it possible to use a detector over the 9-13 micron range.

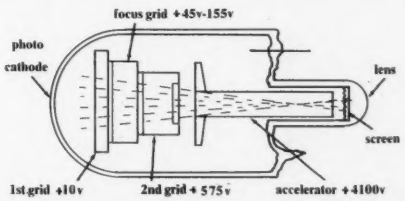
Line 2 is a focus of all the peaks over the temperature range of the infrared spectrum. It is related to diagram 3 which shows three curves as an example.

The infrared range is divided into three. Electron transmitters are in the near range, photoconductive



The Unicam: Rays heat gas, it expands, moves a contact.





Infra-red radiation and electrons = an image

Diagram 3 *(left): Black body wavelengths and radiation intensities for three temperatures.*

Diagram 4 *(above): An inside look at the 1P25A electron image tube by RCA Victor (see story).*

Infra-red *(continued)*

detectors in the middle and thermosensitive detectors are in the far range.

Any warm object radiates energy in all wavelengths —but a peak radiation will happen at a certain wavelength for every temperature. The warmer the object, the higher the peak moves up in terms of frequency.

Now what snags make it difficult to detect this peak radiation? There are a few. For instance, there is a good deal of absorption by water vapor over a large part of the spectrum. But there are some gaps—or windows—which mean we can use parts of the spectrum to the full.

Then the transmission quality of the optical materials have to be remembered; for the near and medium infrared regions glass and quartz are good. But they tend to cut off the sensitivity of lead sulphide detectors between 3 and 4 microns. For the far infrared, quite different optics are needed. Single crystals of silver chloride rolled flat have proved best at this end of the scale. The Germans developed an excellent crystal (thallium iodide) which transmits to 30 microns.

Infrared receivers must, of course, be sensitive to frequencies which are outside the scope of the human eye. A caesium cell (or a caesium-silver-oxide photo-emitter) is sensitive to approximately 1.2 microns; the lead sulphide cell has a sensitivity which covers the medium infrared region—and is used with the gap that occurs in the atmospheric absorption curve at about 4 microns. Much of the equipment built by the Germans during the war used these cells.

The far infrared region is mostly confined to detectors such as bolometers, thermopiles and thermistors.

Because the sensitivity of the detector is the most important part of infrared detection equipment it is on this that future work will be concentrated. The aim will be to improve the efficiency of receivers.

The Germans have been working on semi-conductor type screens for image forming in the medium infrared —with the target as a radiator. But, in general, images may only be formed in the near infrared using caesium photo-cathodes. With this arrangement, the target must be illuminated due to the cathode's low sensitivity and slow response.

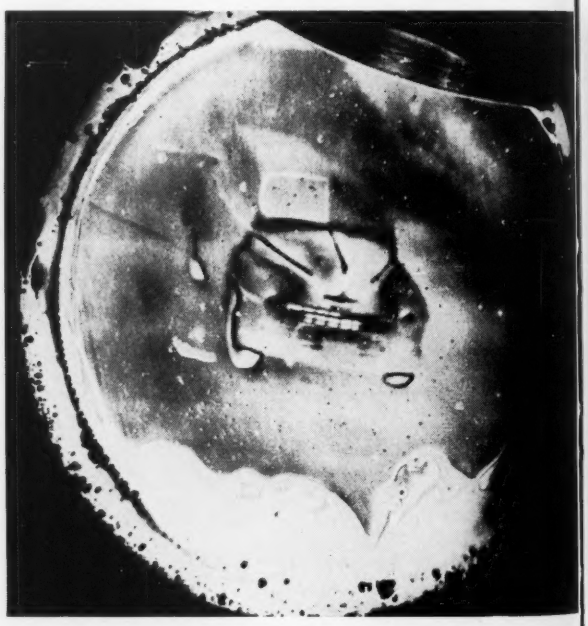
For its sensitive element, the caesium tube uses a photo-cathode of caesium silver oxide. When infrared radiation in the near region strikes the silver oxide, it is absorbed in the crystal grid. This releases electrons from the surface which are collected at the photo-cell anode.

In RCA Victor's electron image tube (known as the 1P25A) the electrons are accelerated and focused onto a phosphor screen to form an image of the electron pattern emitted from the detector.

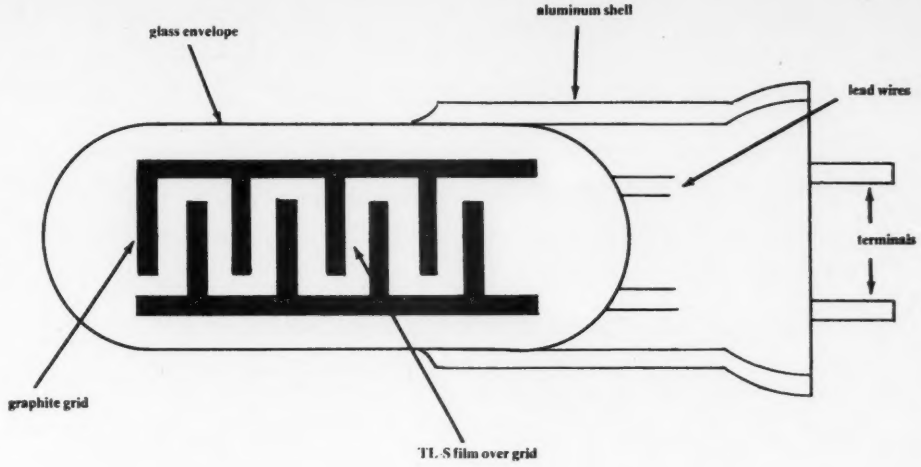
The 1P25A (see diagram 4) is of the electron image tube type. It works like this: The photo-cathode is sensitive to the image formed on it by a lens—which passes on the infrared radiations of the target. Electrons are emitted in proportion to the intensity of the elements of the image; they are accelerated through an increasing-potential field and are made to strike the phosphor screen. This gives a visible image. Infrared radiation is converted to electron energy which, in turn, is converted into a picture you can see. The lens

Pictures, clear enough to be photographed, show up on a film of oil

An aircraft photographed in total darkness. The warm parts show yellow, cold wings and fuselage look blue.



"Eva" can tell that this car has been driven hard. The tyres and radiator show the same color. Both are hot.



Semi conductors also can detect

Diagram 5: *When infrared meets a thin film of thallous sulphide, current flows to detect it.*

at the screen end of the tube acts as the first stage of ocular magnification.

Photoquench phosphors, prominent in the medium infrared region, have a special value. Lead activated zinc sulphide, for instance, is peculiar in that it can be charged—then caused to give up its stored energy when illuminated by infrared. The energy is given off as visible light. So here is an image forming device which, unlike the electron tube, needs no power supply.

There is a place also for semi-conductors in infrared detection. These materials belong somewhere between a conductor and an insulator. A photo-semiconductor when it is reached by radiation at the right wavelength goes through a conductivity change which can be used. The type A thallous sulfide photo-conductive cell put out by General Electric is a good example of this. It is sensitive to roughly 1.4 microns. Two terminal grids have a film of thallous sulfide evaporated over them. When this film is acted on by infrared rays it changes its conductivity to allow more current to flow. In this way it detects infrared radiations. (See diagram 5.)

The Germans again have been active with this idea. They developed lead selenide cells with a response to about 5 microns and lead telluride cells which are sensitive to about 6 microns. But they found that both types needed to be artificially cooled if they were to work best in the longer wavelengths.

Certainly infrared is going to be an important factor in future wars. Its use on a widespread scale would mean many changes in military tactics—as night is turned into day. And there seems no doubt that its use will be widespread; great strides are being taken in developing better, more efficient component parts and counter infrared measures are becoming a steadily greater part of military planning.

But infrared's future is not going to be restricted to the military strategists. It is going to have many civilian uses as well in several different industries.

There are three broad areas which have specially promising possibilities: Haze penetration; temperature measurements; and spectroscopy.

With an infrared detector it now becomes possible to detect heat through haze conditions which might defeat other methods. The location and extent of fire in buildings or forests can now be judged through thick smoke screens—or fog conditions.

Infrared image tubes (in the near range) used in optical pyrometer systems will make it easier for industry to measure temperature variations with great accuracy. As examples: The device could be used to detect a hot joint—for instance where a spliced electrical connection is building up a resistance. Or it could be used for checking railway car axles, looking for the old danger of a hot-box.

Also, infra red is likely to be used for testing surfaces for even radiation of heat in ovens and heating panels.

Then, in spectroscopy infrared will help with chemical analysis. It will identify materials by using their absorption spectra in the 25 microns and 100 microns ranges.

Photography is going to be a very important infrared subject in the future—including aerial photography. Some objects absorb infrared radiation while others tend to reflect it. For instance, chlorophyll in live green foliage, although it absorbs a great deal of visible radiation, reflects infrared. So foliage will show as a bright white in this type of photography. Cities and sea, on the other hand, because they give off little infrared, will show up dark. So very high-altitude infrared pictures can map out terrain—even if there is a heavy haze which would make ordinary photography impossible.

Infrared photographs are also being used in medicine (the skin is transparent to infrared radiations), criminology, botany, paleontology and other scientific fields. Its future seems just about unlimited. ★

Why shape an engine like a triangle?

Design knowledge shows that small multiple cylinders give lower wt. per hp: You can group multiple cylinders compactly with delta-shaped engine

By William Morse

ENGINEERING EDITOR

The Napier Deltic diesel is a two-cycle, opposed-piston engine with a novel layout. The cylinders are arranged in the form of an equilateral triangle.

The engine therefore consists basically of three opposed-piston engines with a common crankshaft at each corner of the triangle.

Deltic engines are at present being produced in two forms, one of which has 18 cylinders and the other nine cylinders. Fifteen-cylinder and 24-cylinder engines also have been designed but not yet built.

The advantages of the opposed-piston arrangement include: efficient end-to-end scavenging, use of generous port areas and gas-flow passages, no complex valve gear, no cylinder-head sealing problems, reduction in heat losses and increased thermal efficiency.

In addition to these, the triangular layout provides an inherently rigid structure and when all combustion loads are taken through high-tensile steel bolts, a robust and light construction results. This allows light alloy castings to be used without any sacrifice in life or reliability, as compared with more conventional materials.

It produces low weight per hp

It is well known by design engineers that small multiple cylinders give a lower weight per horsepower than a smaller number of large cylinders. The triangular disposition makes it possible to group multiple cylinders compactly together to achieve the advantages of short length and compactness with low weight per horsepower.

The use of multiple cylinders reduces the dimensions of the main engine components to an extent which gives the greatest possible latitude in the choice of materials, heat treatment and manufacturing techniques. The components also become suitable for quantity production methods and this results in complete interchangeability of parts and low production costs.

The triangular layout imposes two limitations on the designer which arise directly from the geometry.

First, in order to obtain the correct firing sequence it is essential for one crankshaft to run in the reverse sense from the other two. Second, a phase difference of 20 deg. between the crankshafts at each end of one cylinder is unavoidable.

These limitations are not severe, for the crankshaft rotation can easily be catered for by suitable gearing. Some phase difference between crankshafts is essential on the high-speed, opposed-piston engine. This is to obtain the necessary displacement of the port opening diagrams to give a reasonable exhaust lead angle, coupled with a smaller degree of inlet lag for cylinder filling.

In the in-line, opposed-piston engine, it is desirable to reduce this phase difference to a minimum, for as the phase angle is increased the torque diagrams, and the power transmitted through the two crankshafts, become widely different. This can be an embarrassment and can lead to difficulties in the coupling system between the two crankshafts.

In the case of the Deltic, however, each crankpin carries one inlet piston and one exhaust piston so that the torque produced, and the power transmitted, at each crankpin are identical. This is a further advantage of the triangular arrangement and this fact allows a phase angle of 20 deg to be accepted without sacrifice. See the resulting porting diagrams.

The three crankshafts are connected through a train of gears. A separate tributary gear train from each crankshaft drives on to a common output gear at the centre of the triangle.

Note how the two top crankshafts are connected through a single idler gear, while the bottom shaft drives through two idlers, to cater for the difference in direction of rotation of one shaft, already referred to.

This gear system is housed in a thin, triangular two-piece casting, known as the phasing gear casing. By a different assembly of idler gears, it is possible to reverse the output shaft rotation, when a handed engine is needed for marine uses.

In its original form, as developed for the Admiralty for use in fast patrol boats, the 18-cylinder engine, equipped with reverse and reduction gear, produces a maximum Shaft Horse Power of 2,500 at 2,000 crankshaft rpm, with a specific fuel consumption of 0.415 lb/SHP/hr. This output has 15-minute limitation.

The continuous power rating is 1,875 SHP at 1,700 crankshaft rpm, with a specific fuel consumption of 0.395 lb/SHP/hr. Under these conditions the running period between piston withdrawals was required by contract to be at least 1,000 hours.

See the performance charts for the stripped engine, that is, the engine without reverse-reduction gear and engine-driven auxiliaries. Under these conditions the maximum BHP is 2,730, corresponding to a bmep of 100.4 psi at a specific fuel consumption of 0.380 lb/BHP/hr. The continuous rating is 2,035 BHP with a bmep of 88 psi at a specific fuel consumption of 0.364 lb/BHP/hr.

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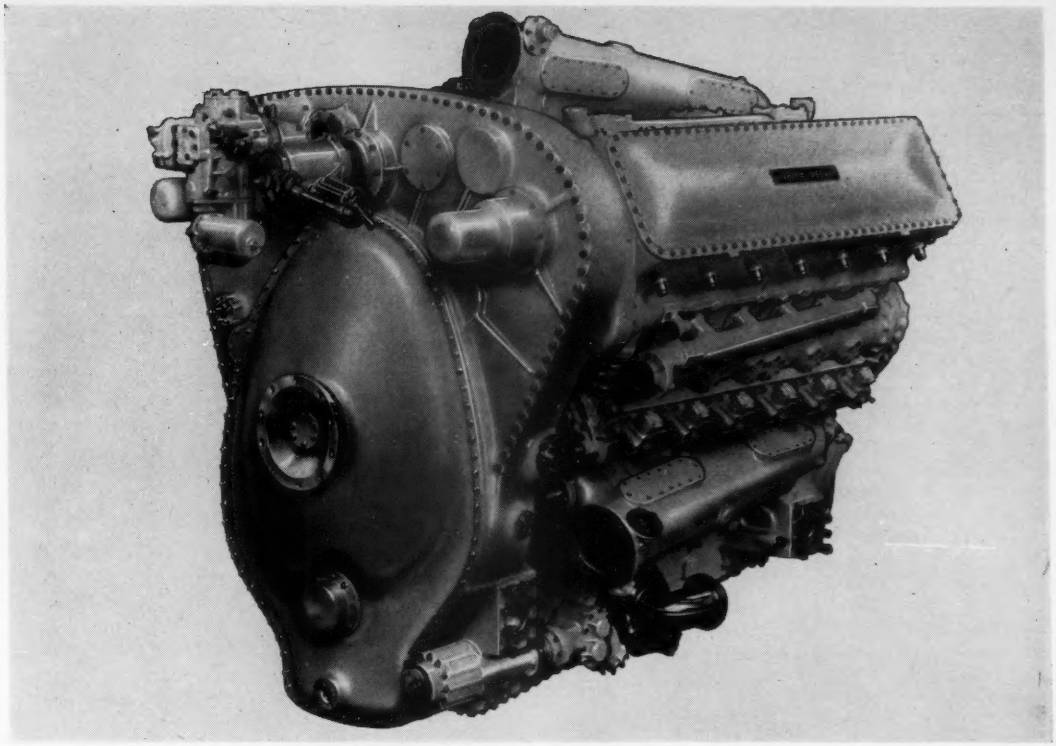
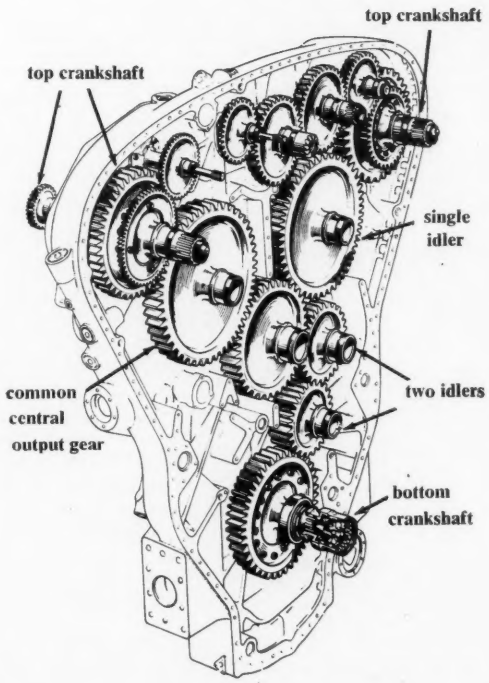
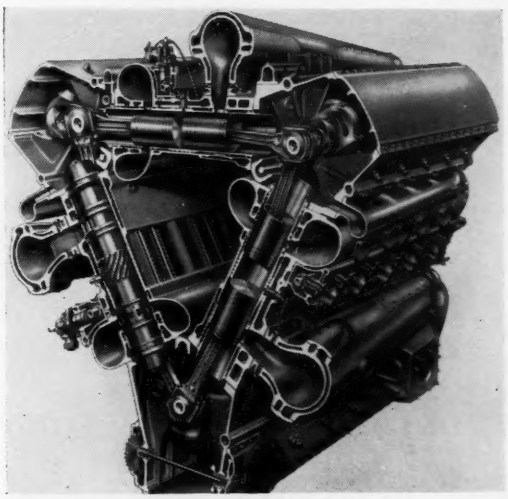


Deltic diesel has one inlet, one exhaust piston arranged to make torque, transmit power same at each crankpin.

You can reduce heat loss, increase thermal efficiency with Deltic diesel





This cross section of the Napier Deltic diesel shows how the three crankshafts in the engine are connected through a train of gears which have a special set-up.

Gear system is housed in a thin, rectangular two-piece casing. By a different assembly of idler gears, it is possible to reverse the output shaft rotation on ships.

Things you should know about the 18-cylinder high power Deltic diesel

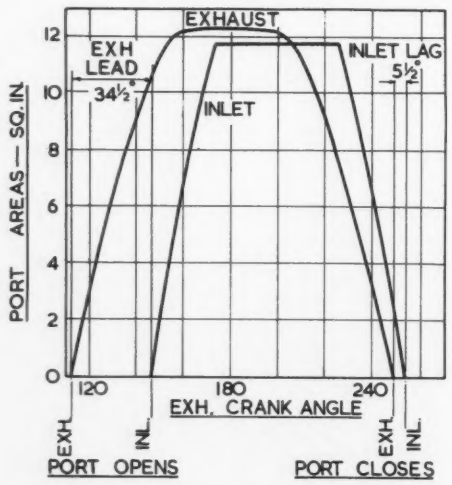
Bore (in.)	5.125
Stroke (in.)	7.25 x 2
Swept Volume (cu. in.)	5384
Swept Volume per min. at max. rpm (cu. ft.)	6230
Rated Speed (rpm)	2000
Piston Speed at max. rpm (ft/min.)	2416
Max. Power (SHP)	2500
Continuous Power (SHP)	1875
Continuous Speed (rpm)	1700
Max. Output Shaft Speed (rpm)	950
Nominal compression ratio	19.26
Specific fuel consumption (lb./SHP/hr.)	0.415

The general qualities of robustness and ease of maintenance, together with its other advantages, make the Deltic suitable for a wide range of applications, even where savings in weight and space are not regarded as of prime importance. Some of the more important uses are: eighteen-cylinder Deltic engines, operating at a high performance rating, are at present being supplied to the British Admiralty and other navies for use in fast patrol boats and similar craft. Eighteen-cylinder and nine-cylinder engines, operating at conditions approximating to commercial ratings, are also being supplied for use in minesweepers, the low magnetic-content of the engine conferring advantages for this type of service.

Nine-cylinder engines at commercial ratings are being supplied for the propulsion of fast passenger launches and customs vessels and experience is showing that there is a wide range of commercial craft in which Deltic engines show to advantage.

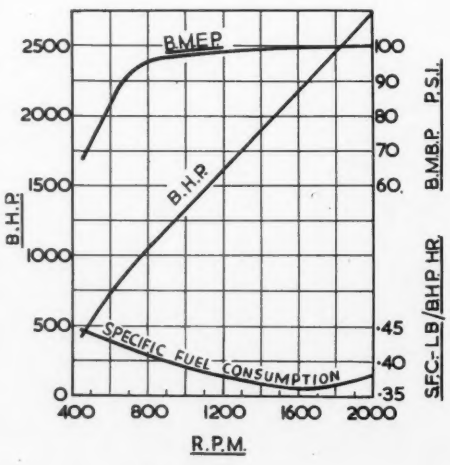
And recently a locomotive rated at 3,400 hp and powered by two 18-cylinder Deltic engines has been constructed by the English Electric Co. Ltd. ★

The torque produced and power transmitted are the same



Unusual porting . . .

One inlet, one exhaust for each crank pin and an acceptable 20 deg phase angle are features.



And unusual power

Without reverse reduction gear or engine driven auxiliaries, a very high 2,730 bhp can be had.

This Flowcoat project will pay its way in months

From the largest outer refrigerator shell to ¼-in. strips for automatic dryers—Flowcoat works on them all

A project that apparently will pay for itself in six to eight months has been installed by the Canadian Westinghouse Company Ltd. in the painting department of the appliance division.

It is an automatic flow coating unit coupled with the use of a specially developed Epon (epoxy) primer which has resulted in the capacity of the department being doubled and the quality of the finishes being improved.

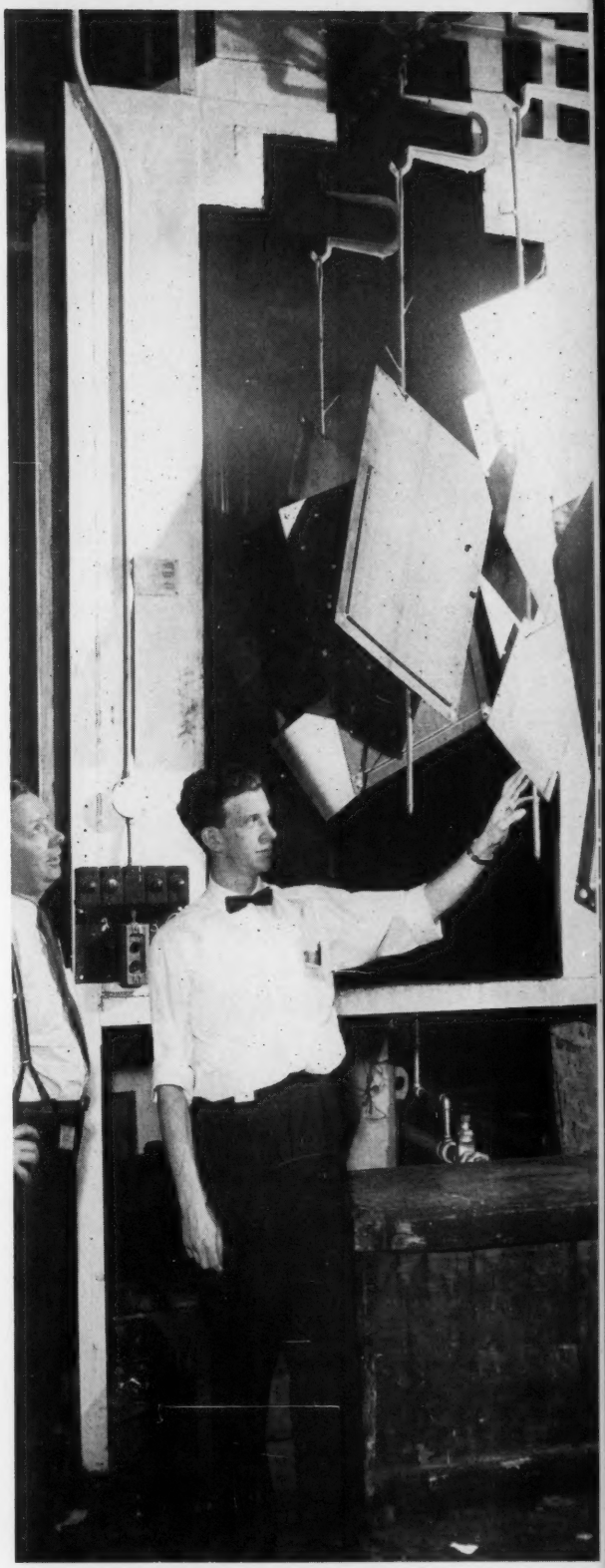
The system is used for processing a wide range of parts for refrigerators, laundromats, conventional washing machines, electric ranges, dishwashers and other products.

These parts vary in size from the outer shell of the largest refrigerator to the ¼-in. wide clamping strip used on an automatic clothes dryer. The equipment does not require adjustments for size of the painted components so the system is completely flexible in a production schedule.

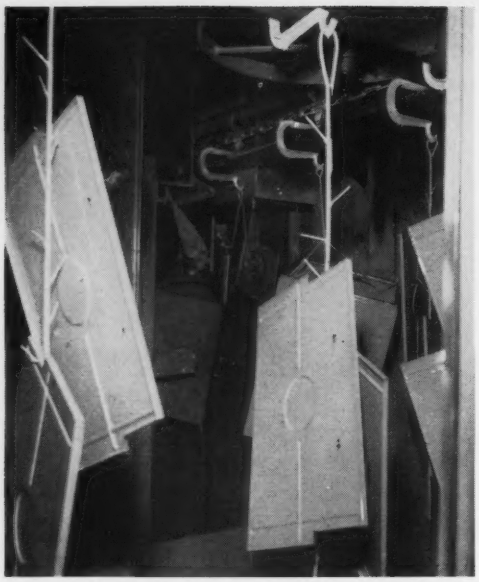
Westinghouse is believed to be the first company using a single system of this type for an entire range of painted domestic appliances.

With the old way of painting, metal preparation (bonderizing) and painting operations were virtually independent, and used separate conveyors moving 64 in. and 31 in. per minute respectively. This meant handling and storage which were costly in manpower and floor space. On the paint conveyor, parts passed through a manual spray booth in which the operator had to turn the hook in order to cover all sides of the appliance. After the prime coat had been baked and "rubbed down," the top or finish coat was similarly applied in a second paint booth. The capacity of this setup was insufficient and even on a three-shift basis, certain products like conventional washing machines, and all black japanned parts were painted on a separate but smaller system.

The new layout provides a single conveyor system linking metal preparation, automatic application of the Epon prime coat, prime baking, limited "rub-down," manual finish spraying and final baking. Conventional washing machine parts are now painted on the main line as are almost all parts previously sprayed with



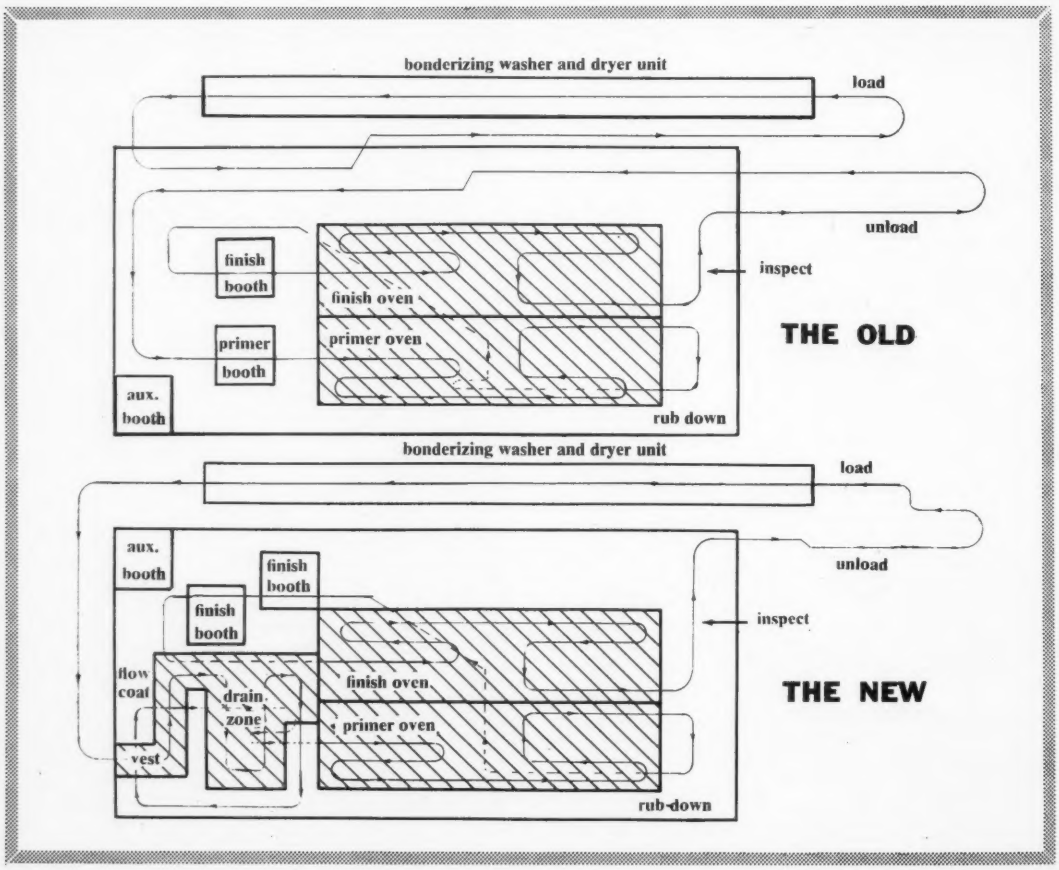
Careful study of shells and panels as they enter metal preparation makes best use of time, materials, drainage.

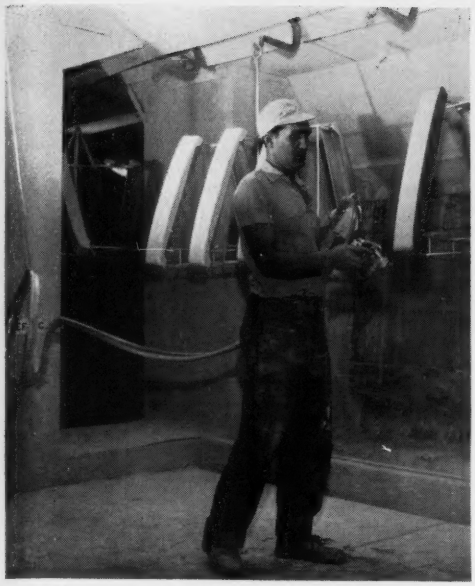


Sprayed from four static nozzles, three rotating arms with two nozzles, parts pass in flood zone.

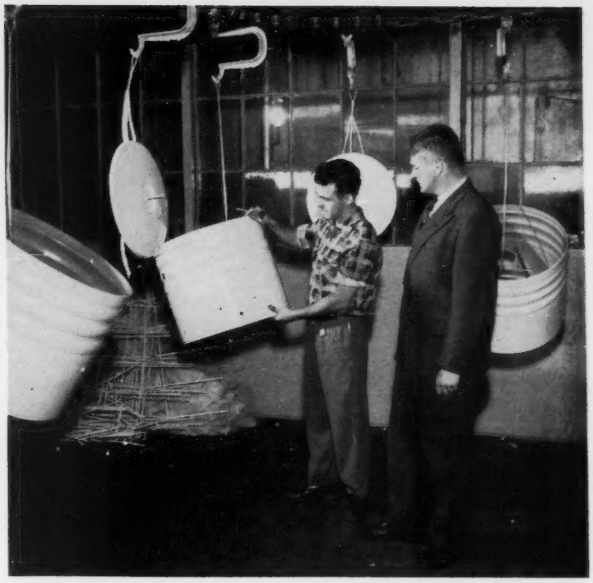
Prime-coat-baked, parts not destined for a second coat are unloaded, others checked for marks needing sanding.

The Epon finish is good enough that often the coated parts need no "rub-down"





Hot spray is used for finish coat. Here panels pass through the first of two spray booths.



After second baking, parts are carefully inspected before conveyor takes them to the unloading area of the system.

or sanding provided there is effective drainage by hook or carrier design

black japan. These are now covered with only a single coat of Epon but this is much harder and hence more durable than the lacquer.

The new primer, having greater resistance to alkalis and detergents, gives better protection to the components of laundry appliances. The conveyor now travels at 64 in. per minute throughout the system. Some of the spray painters who are no longer required for putting on the prime coat double-up on the finish spraying to compensate for the greater conveyor speed.

The pressure with which the metal cleaning, rinsing and prime coating solutions are applied to the articles makes it desirable that conveyor hooks are rigid about their own axis. They can't be revolved in a spray booth. The two finish coat booths are on opposite sides of the conveyor so that each sprayer paints half the load and does not have to waste time and energy on turning the ware that passes through their booth. Self-indexing hooks are more costly and unnecessary this way.

The flow-coating unit and the main drain zone had to be located on the mezzanine floor above the enclosed paint shop for several reasons. The two gas-heated convector type ovens are also located on this floor, but are of the "A" Type construction and must therefore be entered from the main floor below. This explains why the conveyor travels back and under the vestibule of the flow-coat unit after it leaves the drain zone. However, the entire section of conveyor is fully enclosed.

Taking advantage of the descent, the floor of the enclosure was also pitched toward the centre so as to form a channel in which Epon paint dripping from the ware collects and flows back to main paint supply tank. The bulk of the paint drains off in the special zone immediately adjacent to the flow-coat or flood zone. Here the evaporation of volatiles is intentionally retarded by a controlled exhaust system so as to maintain relatively low paint viscosity required for both economy and good finish.

Storage or supply tanks for paint and thinners are located on the main floor immediately under the flood zone. Good return drainage is therefore assured and barrels of paint do not have to be transported to another floor. Two pumps operate the flow-coat unit. The larger of the two supplies paint or thinners to the upper floor, while the auxiliary pump is used to circulate and filter the contents of the "idle" tank.

Thinners are pumped through the system to flush down the pipes and floors of the unit at the end of the day or at the end of the week if on three-shift operation. A small bleeder valve, which is also connected to the circulating pump, maintains the solvent content of the paint mixture as it passes through the system during the painting cycle. Nevertheless the viscosity is checked hourly to ensure uniformity of finish. The paint applicator is fitted with automatic heat exchangers to ensure that there is no variation in temperature at the point of application.

The Epon finish is in many instances so good that no "rub down" or sanding is required. This depends mainly on the effective drainage provided through careful hook or carrier design.

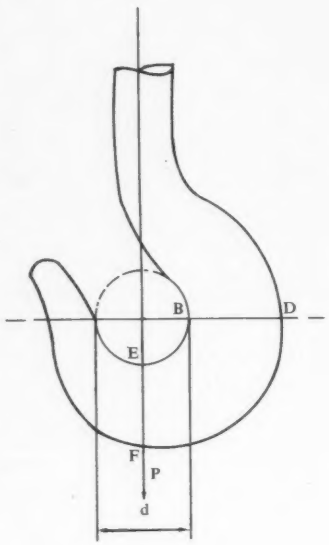
The new paint facilities for the appliance division were installed with a loss of production of only 1½ days. The actual down time was five days but included the annual inventory and a normal weekend. The conversion included radical changes in every part of the metal preparation and paint departments. All conveyor track had to be raised even where it remained in the same plan location, oven ducts had to be replaced to provide clearance, and new spray booths had to be erected as well as the old one completely dismantled.

Needless to say in the paint shop work could not re-start until the last sprinkler **Continued on page 64**

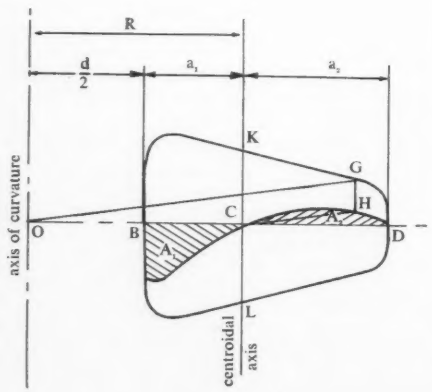
Find stress in curved beams graphically

This quick way is ideal for stressing crane hooks or other like parts

By J. Teks, P.Eng.



A crane hook under load . . .



. . . and its stress diagram

The neutral axis of a straight beam coincides with the centroidal axis and the stress in any fibre is proportional to the distance of that fibre from it. But if the beam is curved, this is no longer true and formulas for a curved beam have to be applied.

Here is a graphical method for computing the stresses in a curved beam, the example taken being a crane hook (see diagram **1**).

The stresses should be computed for section BD and EF. Diagram **2** shows section BD to a larger scale and a method of finding the stresses in this section will now be given.

For practical purposes, the maximum stresses are usually the most important. The maximum tensile stress will be at point B and the maximum compressive stress at point D. Stresses between these points are lower and at the neutral surface, which lies somewhere between B and the centroid C, the pure blending stress is zero.

Find the area A of the cross-section. Locate the centroid C of the cross-section and draw in the centroidal axis KCL. The above section is symmetrical about the centre line and C therefore lies on BD.

Now draw from the centre of curvature O a line OG to the outline of the cross-section. Draw a vertical GH from G. The cutting point H of this vertical and a line CH parallel to OG from C gives a point H on the outline of the shaded area A_2. Draw more lines at regular intervals to get more points on the outline of areas A_1 and A_2. Connect the points and find the areas A_1 and A_2. If the cross-section is not drawn full-size, multiply the areas found by a scale factor to get the areas of the full-size cross-section.

Formulas for Maximum Stress

Maximum tensile stress psi (at B)

$$= \frac{P}{x.A} \cdot \frac{2a_1}{d} + \frac{P}{A}$$

Maximum compressive stress psi (at D)

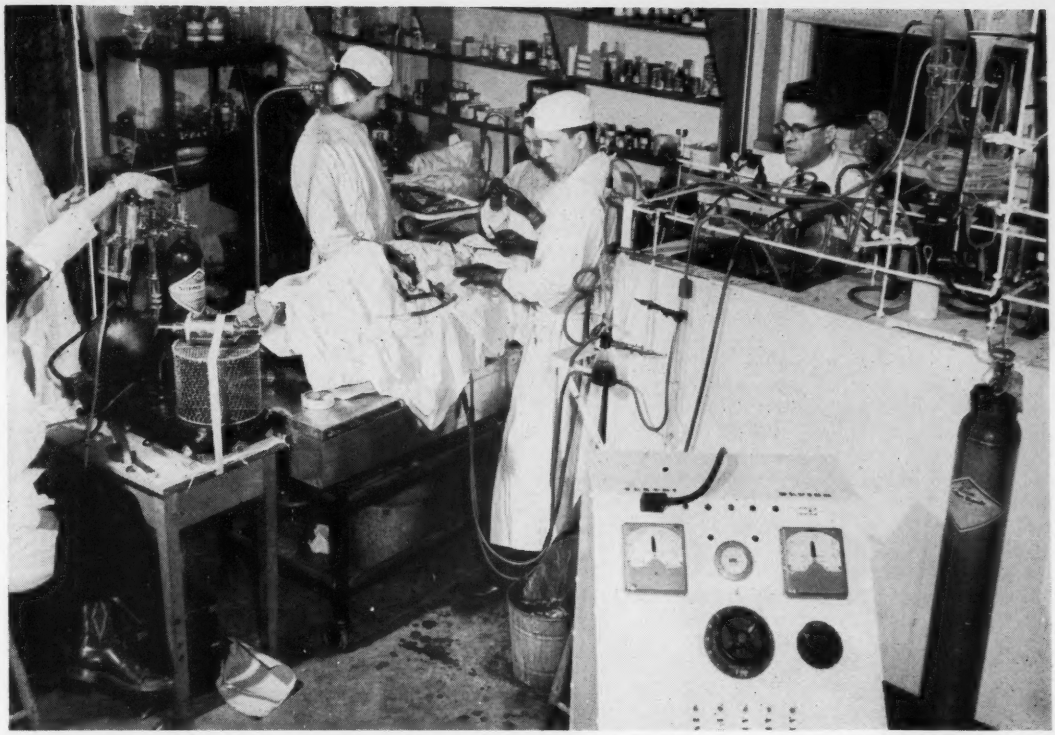
$$= \frac{P}{x.A} \cdot \frac{a_2}{R + a_2} - \frac{P}{A}$$

Where P = max. hook load (lb)
A = area of cross section (sq in.)
$x.A = 2(A_1 - A_2)$ (sq in.)
and a_1, a_2, d and R are the lengths (in.) shown in diagram **2**.

The distance between the neutral and centroidal axes is given by:

$$a_o = \frac{xR}{x + 1}$$

Here a_o is, of course, measured from the centroidal axis inward toward the centre of curvature. ★



Stern appearance of researchers with mechanical heart and Dr. Tremblay right reflect momentous medical feat.

Creative engineering

Could we live by a mechanical heart?

We don't know yet, but with it animals have already survived operations

By Brian Cahill

A Quebec City biologist with a flair for creative engineering has designed and built a machine that has made medical history by taking over the functions of the heart and lungs of a large dog for more than one-and-a-half hours.

The machine, the result of six years of work by Dr. Jean Louis Tremblay, professor of biology at Laval University, has been described as a "mechanical heart." Dr. Tremblay says he does not know what the machine (on which he has applied for patents) will eventually be called, but he says the best description of it at the moment is "an electro-magnetic heart and lung device for surgical purposes."

Its job, he explains, is to take over during a surgical operation "the work of the heart in pumping blood through the body," and "the work of the lungs in supplying the oxygen that purifies and renews the circulating blood."

In the cluttered laboratory of the Department of Biology of ancient Laval University surgeons have tested the device on dogs and other animals without harming them in any way. They have laid bare the hearts of such animals and, working easily because of the absence of blood, performed the equivalent of major heart surgery. Longest time they have used the machine with an animal has been an hour and a half—plenty of time to perform all but the most complicated of operations.

Such freedom of action has been the dream of the heart surgeon for many years. He knows of many heart conditions that could be corrected were it not for the danger to life that lies in cutting off the circulation of blood for more than a few minutes and for the difficulty of operating in a "surgical field" that is obscured by quantities of blood.

Dr. Bernard Paradis, Dr. C. Levasseur and Dr. Vincent Gauthier, all of Quebec City and connected with the teaching and research staff of Laval, have assisted Dr. Tremblay in the practical application of his heart and lung device to the problems of surgery. Specialists in heart and lung surgery and in anaesthesia, they display scientific caution in predicting how soon the device may be used on a human patient. But they are sure that the idea behind the device is medically sound and their experience so far with laboratory animals has been "most encouraging." **continued over page**

Mechanical heart *(continued)*

Dr. Tremblay (whose degree is a Ph.D. in biology) is quite content to leave the decision of when and where to use his invention to the surgeons. But he is perfectly confident that the machine can now be used on humans with as much safety as any one of a dozen other mechanical devices, such as anaesthesia machines and the well-publicized "artificial kidney," that are used in modern surgery and medicine.

He bases his confidence on the intensive study which he has made, as a biologist, on the circulatory system of living creatures, including man, and on the fact that over a six-year period he built his electro-magnetic heart and lung device for surgical purposes in his own laboratory almost entirely with his own hands.

Skilful but not extraordinarily difficult surgery is required to "hook up" the machine to the circulatory system of a living being. Major blood vessels leading to and from the heart are severed and the blood is diverted, via rubber tubes, through the machine instead of through the heart and lungs.

As soon as the operation is over the blood vessels are rejoined and the heart and lungs go back to work.

The idea of a mechanical substitute for the heart of a human being is not new and scientists have long been able to purify blood outside the body by bubbling oxygen through it. Dr. Tremblay says, however, that the basic weakness of one or two machines previously developed to act as "pumps" in place of the heart has been inability to adjust to the varying requirements of the human body.

A machine which merely pumps the blood along at a steady rate and pressure is dangerous because different bodies, and changing conditions within the same body, require delicate adjustments of pressure and flow.

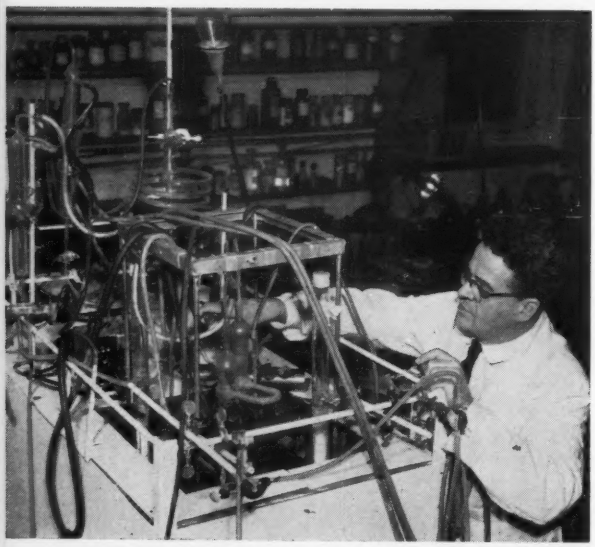
Dr. Tremblay's device adjusts automatically to the different requirements of the body and there is no danger of abnormally high or low blood pressure during an operation.

Dr. Tremblay is, of course, primarily a biologist, but he has always had what he describes as a "mechanical bent." He became convinced at an early stage in his career that a machine could be built to do the basically simple job of pumping blood through the human system and subjecting it, at one stage, to what is known as "hematosis"—a cleansing and renewing process that takes place in the lungs of mammals.

The machine, weighing about 1,400 lb, actually works in a simpler, more direct manner than the approximate 2 lb of human muscle and tissue that it is designed to replace.

Dr. Tremblay describes it as being really two separate pieces of apparatus incorporated in one machine: a pumping device and a device for hematosis connected together.

The pumping device is patterned after the heart of a fish. Fish have hearts of a more simple design than those of mammals. The fish heart, known to biologists as a "two-cavity heart," pumps blood to the gills, where the process of hematosis takes place. From the gills the blood goes directly to the other parts of the body of the fish before returning to the heart to start over aagin.



Hematosis device, very complicated, has blood pumped in at base of a coiled 20-ft. glass tube. On way up the blood is mixed with fractional bubbles of oxygen.

Mammals have two 'hearts'

The mammal (human) heart is a "four-cavity heart." Compared with the heart of a fish the heart of a mammal is actually two hearts. Indeed, doctors and other medical scientists usually speak of "the right heart" and "the left heart" of their patients.

The "right heart" pumps the blood to the lungs where it is hematosed by oxygen supplied by the breathing process. After hematosis the blood returns to the "left heart" whence it is pumped to all parts of the body.

Dr. Tremblay decided that his device could be based on the relatively simple circulatory system of the fish, in which the blood goes through the "pump," or heart, only once during a complete cycle.

To accomplish this he needed the equivalent of the gill of a fish and this, in effect, is what his second piece of apparatus is.

He calls the first piece of apparatus "the pumping device" and his second piece "the hematosis device."

The pumping device, patterned after the simple two-cavity heart of a fish, consists of two bellows connected by a collar containing a valve. This valve is copied from and functions like that of a "natural heart."

There is a similar valve at the entrance of the blood to the bellows and the valves are so arranged that the blood can flow in one direction only (see circuit diagram).

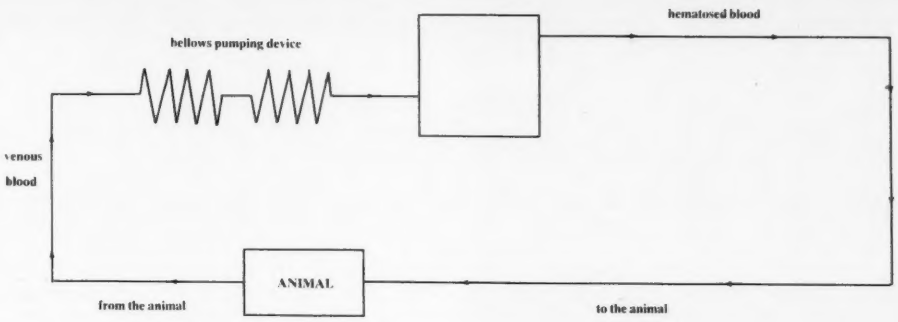
A soft iron ring surrounds the joint between the two bellows.

To operate the pumping device the bellows unit, with the soft iron ring in position, is placed inside a set of two coils which are alternately energized with electric current. This creates a magnetic force in opposite directions and causes the soft iron ring to move to and fro inside the coils and sets the pump in action.

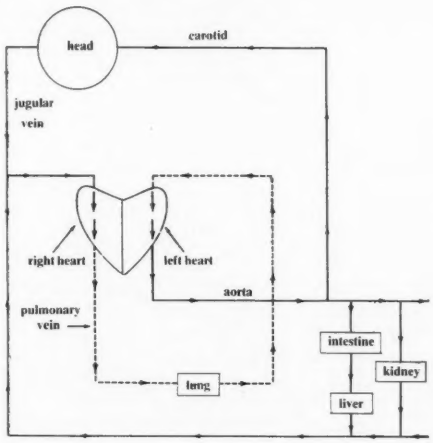
The hematosis device is somewhat more complicated. The blood is pumped in at the base of a coiled, 20-ft. glass tube. On its way up the spirals of the tube, the blood is mixed with bubbles of oxygen, a bubble of oxygen alternating with a fraction of blood.

As it travels through the **(Continued on p. 78)**

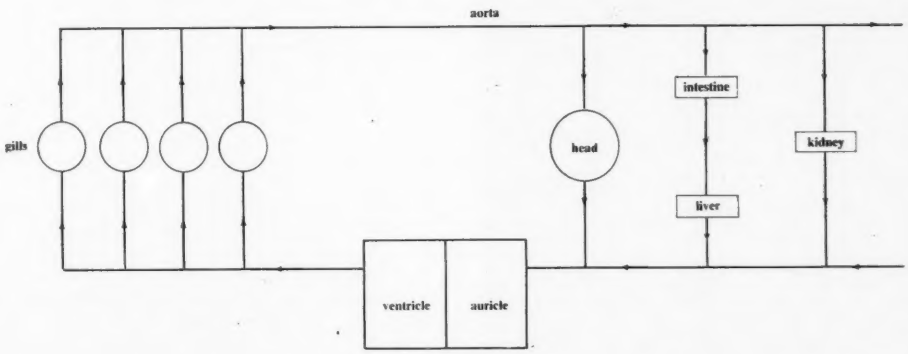
Mechanical heart is a pumping and hematosis device which are combined



The mechanical heart is patterned after the heart of a fish which has a heart of a more simple design than mammals. Block diagram above shows how the venous blood is pumped from the animal by a bellows pumping device. The blood is hematosed with oxygen, returned.



The human heart, left, is a four-cavity heart. Compared with a fish heart it is actually two hearts. Often doctors and other medical men speak of the "right heart" and the "left heart" of their patients. The right heart pumps the blood to the lungs where it is hematosed by oxygen supplied by the breathing process. After hematosis the blood returns to the left heart whence it is pumped to all parts of the body. Dr. Tremblay decided to base his device on the relatively simple idea of the fish, which has a simplified circulatory system in which the blood goes through the "pump" or heart only once during complete cycle. His new invention which has taken over during an animal operation works on the same principle as a fish's simple heart.



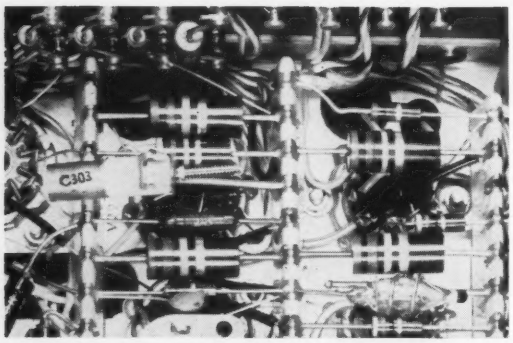
The fish heart which is the basis of device is outlined in the above diagram. Inventor Tremblay needed the equivalent of the gills of a fish, which he designed by using two bellows connected by a collar containing a valve. As the diagram indicates, blood goes through the fish heart only once during the complete cycle. In the mechanical heart there is a valve arranged so that the blood can only flow in one direction — it is exactly the same idea.

Design the modular way to economize

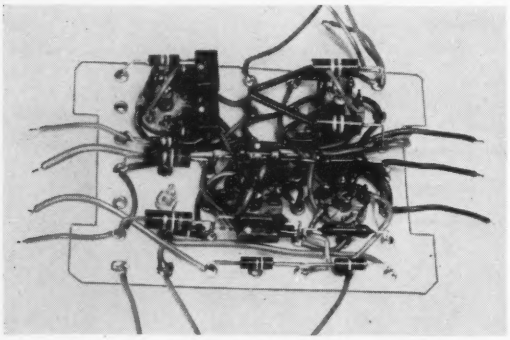
By D. E. Nuttall

FERRANTI ELECTRIC

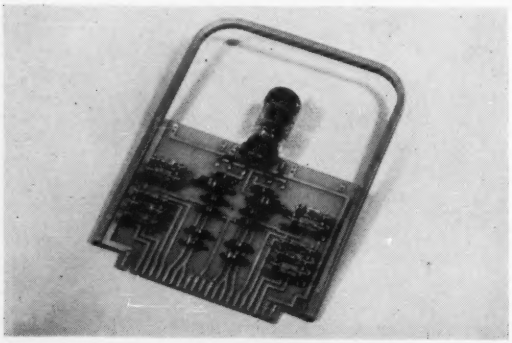
Dimensionless drawing of circuits cut down design and drafting costs



This is portion of a hand-wired electronic chassis involving many special parts in the chassis construction.



And this is a hand-wired electronic circuit board with the components wired to a standard "eyeletted" board.



The printed circuit board, however, involves only one special part in its own dimensionless assembly diagram.

One of the brightest stars on the electronics horizon is the computing machine. The so-called electronic brain appears to have the ability to churn out answers to awesome mathematical problems that are poured into it. But it is not as simple as all that, either in the way it works or in its design.

Consider the design aspect. Some computers have become obsolete before the prototype is begun. The temptation to skate from one technique to another is partly to blame for this situation, which is not unlike the state of affairs in the groping automobile industry in the early 1920s:

The clever ideas were there but the painful and sometimes dull business of engineering a useful and a reliable product had just begun.

So it is today, not only in the design and building of the computers, but many other electronic devices. And, as in the auto industry, electronic manufacturers have found a way in which to carry out numerous experiments, yet incorporate only those features which prove valid. They do it with modular design technique—laying bricks electronically with packaged circuit variations.

Critical circuits are designed so that they fit into the entire machine: They can be plugged in or unplugged and another unit inserted in their place.

To refer to the evolution of the automobile industry again, creativeness here becomes mixed in the proper proportion with a kind of engineering discipline — a discipline enforced by mechanization and competition.

But discipline need not hinder design. It can, in fact, create new opportunities as long as electronics engineers and management can distinguish the good points of discipline from the bad.

Our experience at Ferranti in the design of computers under the conditions I have mentioned bears this out.

Habitually, we have only considered the use of a new technique or a new piece of tooling when it can directly save labor.

Yet cost savings may be greater in other areas which are not as a rule considered. See the picture for instance which gives a comparison between conventional hand-wired chassis; hand-wired panel mounting circuit involving a board with a standardized pattern of eyelets and socket mounting holes; and a printed-circuit plug-in.

Neither the conventional hand-wired electronic chassis nor the hand-wired electronic circuit board could be wired by a mechanized process. And many special parts have to be placed with care by considerable drafting.

Only special parts and no drafting effort is involved in the hand-wired electronic circuit board since a stan-

dard mounting board is used from unit to unit.

Only one special part is involved in a printed circuit board involving one special part which serves as its own dimensionless assembly and servicing drawing. It is derived from a dimensionless drawing since all component junction points are template-positioned at regular intervals.

This assembly is vastly superior in serviceability.

In conventional assemblies like the hand-wired electronic chassis with many parts and the hand-wired circuit board we expect that some 60% of the total labor will be used up in the wiring phase alone. This includes the preparation of wires, jumpers and cables as well as soldering.

Theoretically, a technique which reduces this labor cost makes mechanization possible as well as other improvements. Printed wiring holds much promise in this regard.

The standardization problem in electronic computers is unique since the solution of one problem may result in one or more other problems.

You need to standardize in printed circuit design which is a vital part of mechanization: It is difficult to achieve and even more difficult to carry out because it is a form of discipline. But it is apparent that printed wiring offers the opportunities: We must decide whether we want to accept the disciplines.

It is a real step in design

Electronic engineers continually struggle with circuits which have critical design problems, which usually appear only after the production stage has been reached. Printed circuits and mechanization help and result in improved quality and reliability of the circuit design in all components.

There are other justifications for printed circuits more than mere reduction in wiring costs which amount to a 40 to 60% savings in direct labor in building and assembly, and a 40 to 50% reduction in labor in testing.

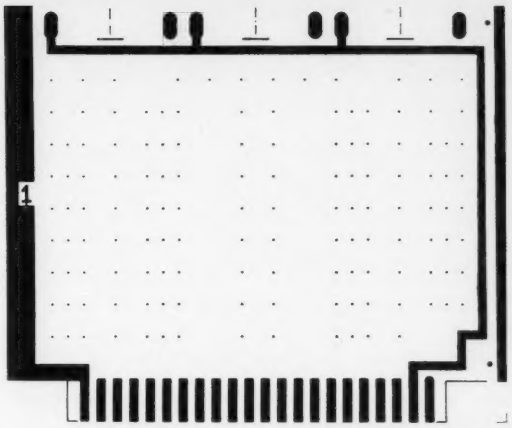
Another costly activity often ignored for example is design and drafting. The processing of the hand-wired electronic chassis assembly requires many drawings, as many as 50 and 60 in larger units of this construction. Each sub-assembly is a special part, each tie point or mechanical support member must be separately drawn and dimensional. The hand-wired electronic circuit board assembly calls for two drawings, neither of which requires the attention of a layout or detail draftsman. The reasons are obvious; the physical dimensions of the board and component mounting spacings are standardized.

The unit assembly and wiring diagram is drawn by an electronic technician with the aid of a printed pattern. The real saving, then, stems from the fact that the mounting board, the only special part required, is essentially a dimensionless wiring and assembly medium. The economy does not stop here: The production effort and complex tooling has been reduced considerably by this approach. And, a reduction in drawings reduces engineering cost as well as manufacturing cost in the whole picture of economy.

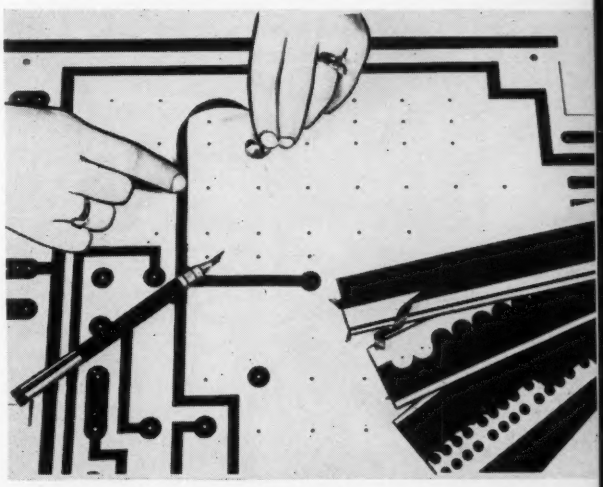
Engineering drawings are handled and processed by many groups, such as purchasing, receiving, test, stock room, machine shop and assembly groups, so reducing the number of pieces of paper to be handled helps lower cost and elimination of errors.

This same approach of using dimensionless drawings can be followed in the drawing of printed circuits. In fact, some of the economies are otherwise forfeited in small lot production. Only six months ago our drafts-

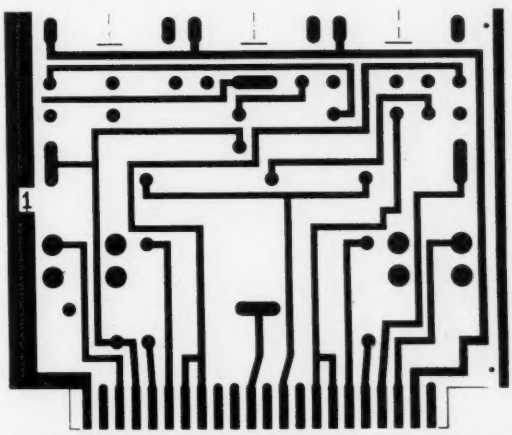
This is the evolution of a circuit



The mounting board above is essentially dimensionless wiring and assembly medium that is only part required.



This is complete set of tools that is used by the layout staff to make master drawings in one to four hours.



Finished printed circuit is the result of making the master drawing and translating by mechanized process.

men laboriously dimensioned and inked in printed circuit patterns. Some took a day and others required many days of exacting work. More important than this, however, was the fact that dimensioning errors occurred in ever-increasing numbers, particularly on double sided patterns, giving rise to many other problems. Now, note the complete set of tools used by layout people for producing master "drawings" painlessly in one to four hours.

Again the detailed draftsman is not required.

The basic layout of a printed circuit panel can and does serve as the detailed drawing of the printed wiring board, assembly drawing and connection diagram. Pictorial layouts can also be derived from it conveniently as well as control patterns for other processes: Board fabrication, assembly; test; and a control technique with only four paper or polystyrene layouts simultaneously dimensioned from a standard grid template.

Everyone knows their job

This printed approach to circuitry is marked by the ease with which fabrication registration or indexing markings and terminal or board identifications may be handled. These appear on an appropriate basic layout. The recording of all the processing information for each circuit requirement is handled by one compact group of people at one time. The co-ordination problems between design and drafting departments are eliminated.

Eliminated too, are the problems between design, drafting and shop on fabrication and assembly and between originators and advertising departments on the reproduction of diagrams and brochures. Unquestionably a mechanized approach will require changes in organization, personnel requirements and training.

The changes taking place in our drafting department show this. There is evidently less need for detail draftsmen and there is less emphasis on wiring or connection diagrams, as well as laborious dimensioning of detail.

There is a demand for men having a sense of special arrangement who can rapidly convert schematics to printed circuit layouts. In our experience, the detail draftsman has been displaced by the technician skilled in cable and wiring arrangement.

How will these changes affect the employee?

The unskilled will not be in demand but there will be a growing need for people with higher skills.

In summary the printed circuit approach to electronics offers opportunity for mechanization; uniformity in reproducing a product; less complicated test problems and better drafting and manufacturing process control. There is a possible reduction in direct labor costs of fabrication, assembly and wiring.

Modular or unitized assembly like building bricks, based on the concept of a functional unit, is a natural outgrowth of printed wiring. In complex computer application, highly standardized modular design is necessary in the printed approach. The electronic engineer, having chosen printed wiring, and modular assembly, forces himself to standardize to achieve his own ends, a form of feedback.

Management faces the military and industrial customers' requirements of rapid fault location and repair or replacement: Bitter experience in trying to meet the military demands of independent unit manufacture and test has been their lot. Management appreciates the military and commercial problems of replacement and supply and they are aware of the practical limits of military training for operating and maintenance of simple equipment. But management is alarmed by the need for computer servicing by only highly trained engineers. Management therefore sometimes has extreme enthusiasm about built-in marginal checking and programmed fault location. Solutions to the problems of computer reliability, time saved in fault location, replacement and repair are as much a key to rapid development of the computer field as the reduction of complexity and of cost.

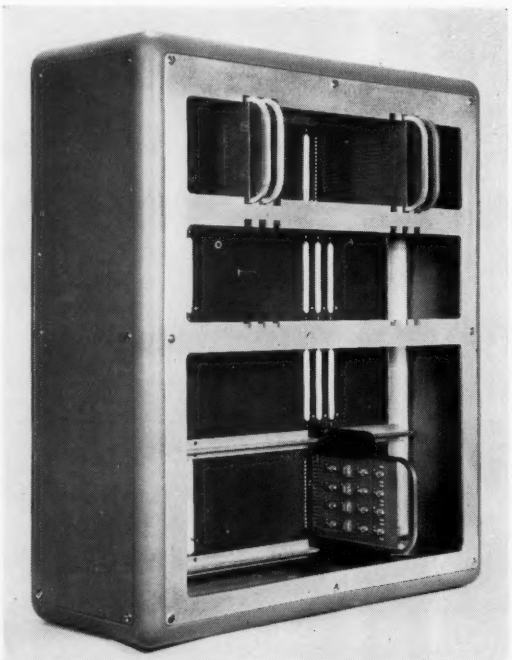
In fact, many large corporations who could afford a computer and have enough work for it still use a centralized computer installation.

Modular design cannot alone solve the problems. But modular circuit design with many combinations of a small number of multi-purpose units might help. The electronic engineer must contrive the key to get the ball rolling. Management must see to it that they provide the necessary task force to develop simultaneously a compatible arrangement of functional circuits and systems to monitor the circuits.

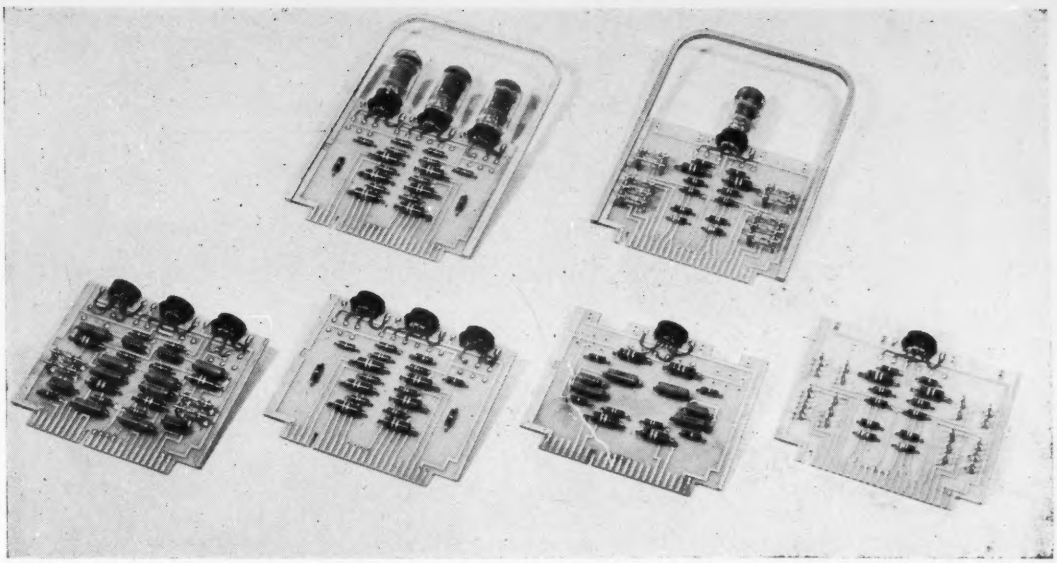
With the printed and mechanized approach, it will no longer be feasible for engineering simply to design and manufacturing simply to build: So changes will have to come.

Modular design based on the concept of a functional unit has to be extended for the digital computer or data processor to read multi-purpose functional unit.

In digital systems, even the most complex logical function may be done by combinations of several differing basic functions. The number of circuit modules we require are few in number. However, we must arrange them so that each one is inserted into the functional assembly in an extremely variable way. The module must be designed then so that its basic function



The interconnected gate packages fit into the cabinet of a computing machine in the way it is pictured here.



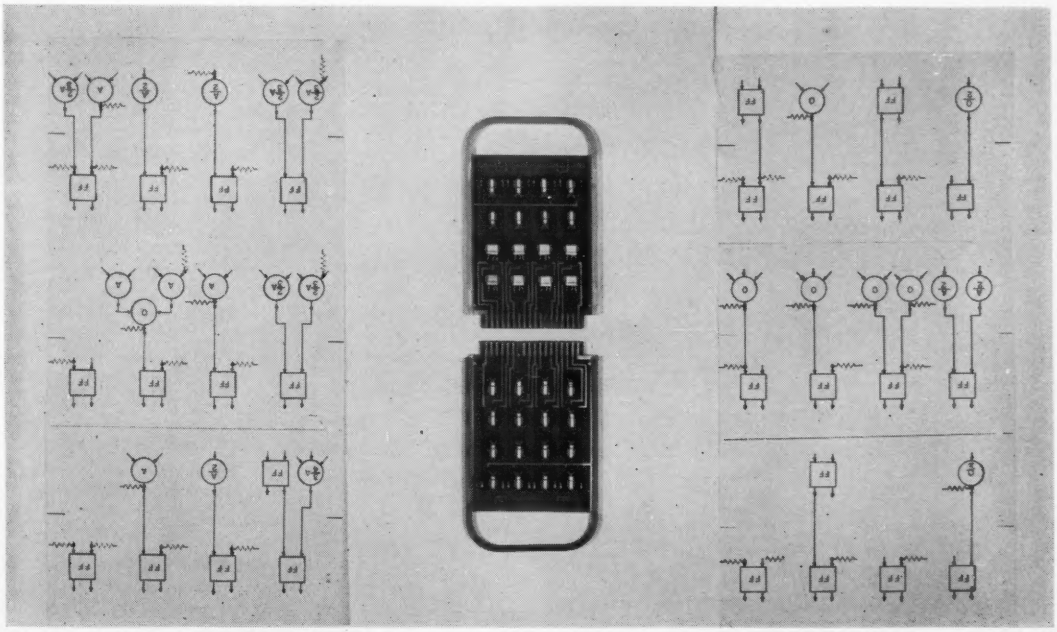
Results of mechanized process in designing electronic components is evidenced in multi-purpose tube packages.

It is not only economical but very practical to design mechanized way

can be varied by making an appropriate set of connections to fixed or standardized wiring and an associated set of components.

An essential module construction feature is the ability to be replaced or interchanged. This approach does this but does not limit circuit flexibility. Modules of this nature are shown designed for use with standard printed circuit receptacles accommodating 44 solder wire wrap or taper pin package connections. The schematics of another layout emphasizes that a large number of terminals are required for multi-purpose tube circuitry to accommodate jumpered internal variations and selection of appropriate input/output impedance and polarity and so on.

continued on page 74



Circuit variations of interconnected F/F gate packages designed for an electronic computer are shown, above.

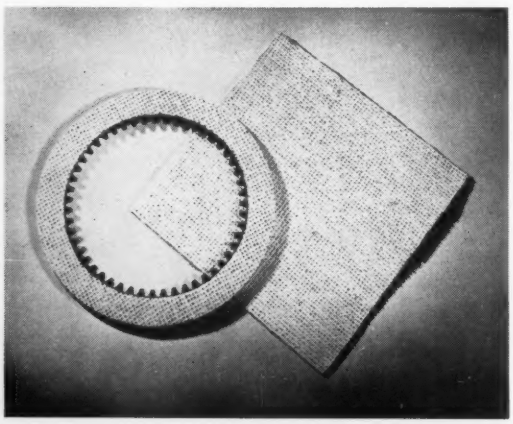
Bulldozers which rile up earth at this forest site depend on clutches and brakes of finest friction materials.

What advances in friction materials?

Today's brake and clutch linings are being made tough and heat-resistant

By K. O. Renz THERMOID COMPANY

Bigger, faster, more powerful machines are wanted for construction and industry today than ever before. The clutches and brakes now required for power transfer and for speed control of giant bulldozers, high-speed elevators and fast industrial machinery of all kinds must be capable of higher performance.



Woven-type friction material can be made from asbestos tapes, cloths, and yarns with different treatments.

And in achieving a streamlined appearance, designers now enclose brakes and clutches which causes them to run hotter than before, when circulating air could cool them.

No single friction material will meet all requirements. In theory, each application is different and a special brake or clutch lining should be made to give the maximum performance for each type of load. This, however, is impractical and would be too expensive. But even with the standardization necessary for commercial operation, a very wide variety of industrial friction materials are available.

To help meet the demands of users and equipment manufacturers for better friction materials, the Thermoid Company has doubled the size of its research facilities. This could not be avoided if better friction materials were to be made.

A clutch is a friction mechanism which, when engaged, increases or maintains the rotating speed of the engaging member. It may be a band or shoe, either external or internal; a disc, either single or multiple; or a cone.

A brake decreases rotating speed when engaged or holds an engaging member at rest. A brake is usually either a band or shoe either external or internal but may take the form of a disc or cone. Stated more simply, a brake is used to arrest motion while a clutch is used to transmit motion.

In either case, the most critical problem is the absorption and dissipation of the heat created.

Desirable characteristics in any friction material are: **1** resistance to wear, **2** consistent performance, **3** high performance under wide ranges of temperature, mois-

ture and pressure, **4** freedom from noise, sparking and disintegration, **5** smooth operation.

In bygone days, speeds were low, loads were light. The prime mover (usually a horse) was used to bring vehicles to a stop. On early freight wagons a heavy wooden stick was dragged on the ground to help control the speed of the vehicle. Then a better braking mechanism was devised which brought a wooden block into rubbing contact with the wheel. But wood wears out fast and chars, giving erratic performance and making frequent replacement necessary. So other materials came into use, such as leather and various metals. But as speeds increased and loads became heavier, the demand for better friction materials was intensified.

The first real brake lining, as we know it today, was a soft, flexible fabric impregnated with rubber. Repeated use compressed the lining and made frequent adjustment of the brake mechanism necessary.

Chief among the ingredients of today's brake and clutch linings is asbestos, because it resists disintegration by heat and possesses satisfactory wear and friction properties. It is easy to process by several methods and is plentiful at an economic price during normal times.

Various metals in particle form are also found in many friction compounds. Brass, lead and zinc are commonly used. All these metals are soft enough not to score cast iron and steel drums and they add to the wear-resistance of the lining, help in heat dissipation and help to break up the uniformity of the lining surface so that "skin effects" are avoided.

Various fillers are used to increase the bulk of the lining and are selected for heat resistance, good wearing qualities and availability.

It is in the development of new resins for industrial friction materials that the greatest advances are being made at present. The thermosetting resins are the chief binder and are selected for heat resistance and wearing properties.

There are seven types of brake lining and clutch facing materials:

1. Wire Back. Ingredients are mixed to a putty-like consistency. A continuous process inbeds the mixture in wire backing. The wire backing member serves two purposes: First, during manufacturing it strengthens the formed but uncured stocks which would be difficult to handle otherwise; second, it increases the structural strength of the brake lining in service, provides greater resistance to the shearing action of the rivets and aids in heat dissipation.

2. Extruded Types. This lining is manufactured by extruding a soft, plastic stock through a rectangular opening.

3. Dry Mix. This is the most widely used method of manufacture in the industry. The ingredients are mixed in a dry state and formed into sheets by pressure and temperature.

4. Thermo Blocks. The compound is compressed by heat and pressure in individual molds.

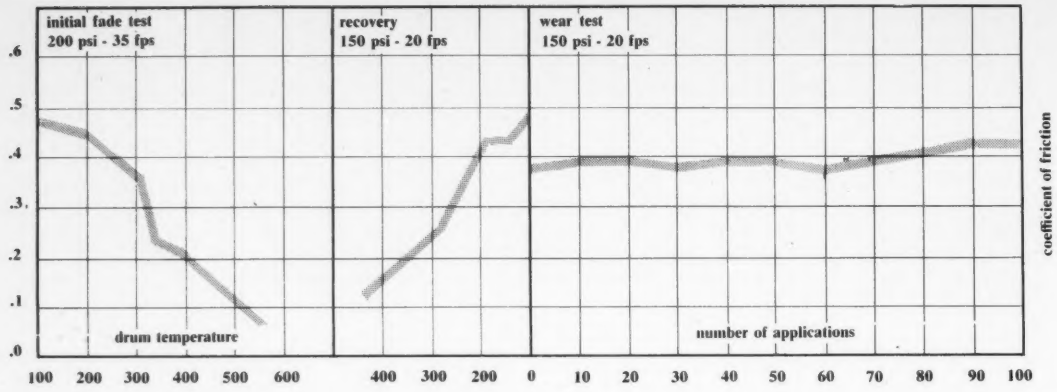
5. Woven Types. Made from asbestos tapes, cloths and yarns. In this large class are a number of materials of different compounds and different treatments. One popular type is made of asbestos yarn with a brass wire insert. The yarn is run through a bath of rubber, resin and other ingredients. The impregnated yarn is dried and then woven into a disc on special machines.

6. Dipped. Special cotton duck is dipped in a liquid solution containing the necessary fillers and binders.

TYPE OF FACING	TYPE OF SERVICE	Maximum Outside Diameter Available	Maximum Thickness Available	Type of Application Oil—Dry	Average Coefficient of Friction	Estimated Wear Factor Cu. In. Per H.P. Hr.	Maximum Temperature	Average Temperature	Surface Pressures Per Sq. In.	MATERIAL
VELVET GRIP	MEDIUM	20"	¼"	DRY or OIL	DRY .34 OIL .18	.0033	500°	300°	100 lbs.	BRASS WIRE METALLIC
HYDRAULIC COMPRESSED	MEDIUM—HEAVY	34"	⅛"	DRY	.40	.0025	600°	400°	150 lbs.	BRASS WIRE METALLIC
HEAVY DUTY	HEAVY	34"	⅛"	DRY	.40	.0025	900°	550°	175 lbs.	BRASS WIRE METALLIC
BX WOVEN	HEAVY	20"	¼"	DRY or OIL	DRY .38 OIL .20	.0032	750°	450°	150 lbs.	BRASS WIRE METALLIC
MOLDED	MEDIUM	50"	1/16"	DRY	.35	.0035	500°	300°	100 lbs.	WITH OR WITHOUT BRASS PARTICLES
RANDOM WOUND	HEAVY	17"	¼"	DRY	.36	.0023	900°	550°	150 lbs.	BRASS WIRE METALLIC
SPIRAL TYPE	HEAVY	17"	¼"	DRY	.36	.0023	900°	550°	150 lbs.	BRASS WIRE METALLIC
DRY MIX	MEDIUM	ANY		DRY	.40	.00122	1100°	700°	200 lbs. PLUS	WITH OR WITHOUT BRASS PARTICLES
E-478 GEAR TOOTH	MEDIUM	36"	1-½"	DRY OR OIL	.25	.0033	900	450	150 LBS. PLUS	MOLDED METALLIC OR NON METALLIC
E-1164 INSULATOR PLATES	HEAVY	36"	1-½"	DRY	.22	.004	1000°	500°	200 LBS. PLUS	MOLDED NON METALLIC

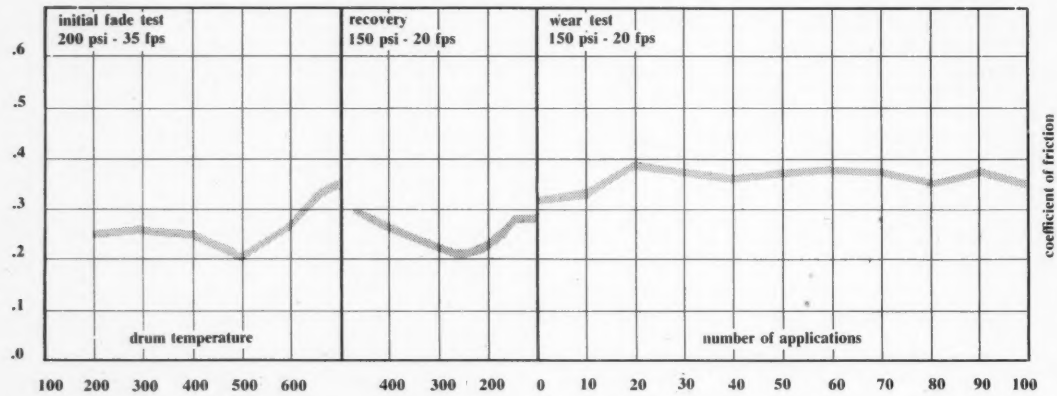
Things you should know if your design problem covers clutch facings (above) or brake linings (below)

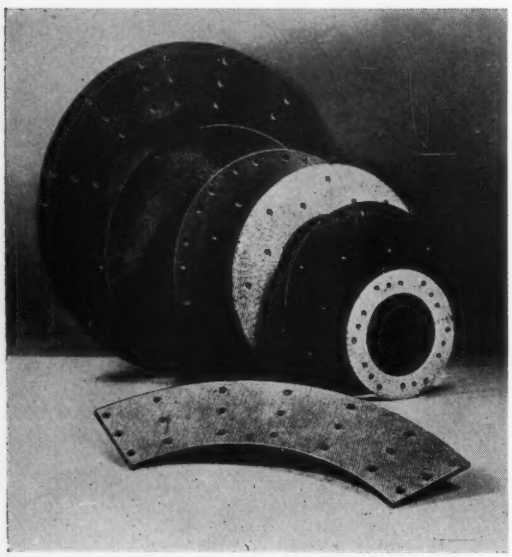
TYPE OF LINING	HEAT RANGE		Type of Drum	Max. Recom. Ft. Per Min. Rubbing Speed	Surface Pressures Per Sq. In.	Average Coefficient of Friction	Estimated Wear Factor Cubic In. Per H.P. Hour	DUTY	SERVICE	MATERIAL	
	Maximum	Average									
TX	750°	450°	IRON	7500	100 lbs.	.45	.0035	MEDIUM	DRY	WOVEN	NON-METALLIC
TXB	750°	450°	IRON	7500	150 lbs.	.45 DRY .20 OIL	.0035	HEAVY	DRY or OIL	WOVEN	BRASS WIRE METALLIC
FML (TRACK MOLDED)	600°	350°	STEEL or IRON	5000	150 lbs.	.42	.0025	MEDIUM	DRY	WOVEN & COMPRESSED	BRASS WIRE METALLIC
PBW	800°	450°	IRON	7500	200 lbs.	.495 DRY .20 OIL	.00260	HEAVY	DRY or OIL	PRESSURIZED WOVEN	BRASS WIRE METALLIC
THERMO BLOCKS	1100°	700°	IRON or STEEL	7500	200 lbs. PLUS	.40	.00122	HEAVY	DRY	MOLDED	METALLIC or NON-METALLIC
WIREBACK MOLDED	700°	350°	IRON or STEEL	7500	150 lbs.	.3	.00270	LIGHT	DRY	MOLDED	NON-METALLIC



How much fade do you want?

Fade varies greatly with different materials. The upper chart shows a marked fade drop-off. This is not always a design disadvantage. The lower chart shows stable fade with a quick recovery. The tests simulate real work conditions—first at high speed, pressure, then at lower speed, pressure as the vehicle slows down.





Size is generally not a limiting factor in making friction materials. Segments make replacement easy, cheap.

7. Woven Asbestos Fibres. Designers and users of oil-cooled, power transmission equipment, such as clutches, torque converters, power take-offs, steering clutches and brakes, are showing interest in a new series of friction materials of woven asbestos fibre impregnated with various oils and resins.

The new material contains no metallic particles or fibres and is lighter and less expensive than metallic friction discs for oil-cooled service. The danger of clogging small ports in the oil system with metal particles is not present.

Although all friction materials in the new series are designed especially for oil-cooled service, flexibility to meet specific applications can be achieved by varying the weave, the impregnating ingredients and the processing treatment.

Because the new material will give results comparable to other types of friction material, it can be used in existing units without changing the design and in new designs with normal engineering considerations.

The new material is designed to be bonded to metal plates with thermosetting adhesives and assembled in oil-cooled units alternately with metal pressure plates. Thermoid will furnish either the friction material alone cut to the required size or bonded to the plates in large volume production quantities.

Action of oil-cooled units using the new material is

smoother because of the cushioning effect of the woven fabric.

Because of the thousands of pores inherent in woven fabric, faster wiping action is promoted resulting in faster positive engagement of the elements.

The thickness of the new material ranges from a minimum of 0.030 in. to a maximum of 0.090 in. in increments of 0.010 in. One piece, full ring diameters are available up to 12 in. OD. Plates of unlimited diameter for this type of service can be obtained by using segmented pieces. The material is available in rings, bands and cones. Any normal pressure encountered in oil-cooled power transmission equipment can be sustained by the new fabric.

The type of duty falls into three general categories—heavy, medium and light. The size or area of the friction surface relative to the weight or mass of the part being controlled determines the nature of the duty. For example, the friction material for a spin-type washing machine might perform under heavier duty than a 40 cu. yd. excavating machine if the space allowed for the friction was small and the rotating speed of the washing machine was fast. Frequency of application is also a factor in the determination of load. If a unit is to operate under variable load conditions, the friction material should be selected for the most severe condition.

Speed is the peripheral or surface speed of the part being controlled and may be classified as:

Low speed = 999 fpm (max)
Average speed = 1,000-3,000 fpm
High speed = over 3,000 fpm

The force (lb) applied by the working parts to the friction surface divided by the area of the friction surface (sq in.) gives the pressure (psi). Pressures fall into three categories:

Low pressure = 5-24 psi
Average pressure = 25-50 psi
High pressure = over 50 psi

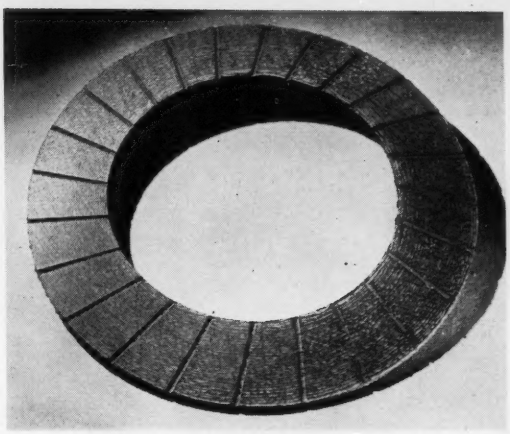
Coefficient of friction is an arbitrary value depending on the testing equipment used. A General Motors machine may give a value of 0.55 and a Bendix machine a value of 0.30 for the same material. To make significant comparisons between friction materials, the tests should all be run on the same machine.

Wear factor is expressed as cu in. per hp hr. A wear factor of 0.00450 cu in. per hp hr means that one square inch of this lining will dissipate 1 hp hour or 1,980,000 ft lb of work while being reduced in thickness only 0.00450 in. This factor will vary but little if pressures are increased and speeds reduced, or vice-versa, provided the changes are kept within the capacity of the lining.

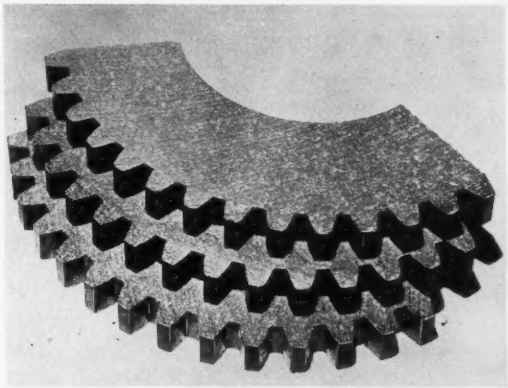
Effectiveness is a factor which represents brake output divided by brake input—or the rate of deceleration divided by the force exerted by the braking mechanism. When comparing different friction materials for effectiveness, the brake output is held constant and the braking pressures are varied. Effectiveness increases directly with any increase in the rate of deceleration, indicating that less pressure is required to produce a stop. A lining with an effective factor of 0.16 will make a stop with less applied pressure than a lining with an effective factor of 0.10.

Industrial friction materials are available in a wide range of dimensions. At Thermoid friction materials are seldom made less than 0.030 in. thick. Although friction materials more than 12 in. wide are rare, they can be made.

Friction material of almost unlimited length can be produced. Size is not often a serious limitation. Many



Radial slots, molded into cord-wound clutch facing dissipate heat, channel out any foreign materials.



Friction materials that are used in making clutches have the teeth molded integrally as in the above photo.

applications requiring a large surface area are often economically serviced by using separate segments, such as wedge-shaped pieces. Building up a large area of friction material with small segments is often less expensive than making one large, single piece and makes replacement in the field easier.

It should be pointed out that the degree of curvature may be a troublesome factor. A small radius job is always more difficult to produce than a large one.

Most brake linings come in short, curved segments. Variations from this standard include brake linings with a small transverse curvature. Another brake lining is made with a definite taper in thickness from one end to the other.

More variety is generally found in clutch facings. We make several varieties of cone. Many of the flat clutch facings are grooved as well as drilled. Other applications call for projecting lugs or indentations to fit specific clutch drive mechanisms.

Clutch linings with integral teeth either molded or machined into the inside or outside diameter are a fairly recent innovation. Thermoid gear tooth clutch facings of this kind are molded complete with uniform pressures exerted. This ensures maximum tooth strength and complete uniformity. Cutting can produce fractures.

It is impossible to measure exactly the temperature

(Continued on page 73)

Photographed in the Showroom of Dominion Furniture Manufacturers Ltd., Montreal.

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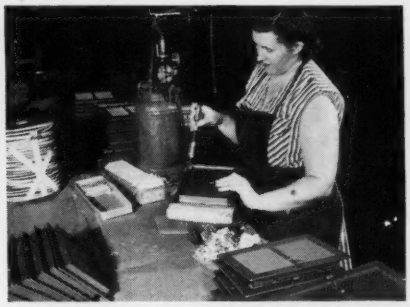

"3M" Adhesive EC-770 being applied to the inside edges of hot air register for bonding a felt strip gasket.

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Are we losing Our industries?

And can engineers Help win them back?

If we are losing control of our own industries, it is because we are not being creative, claim these engineers

J. D. Orr (left) and Alex. Barrie (right) led discussion.

On Thursday night, April 12, a group of engineers met to discuss the dependence of Canadian industry on foreign influences. Events may prove it to have been a very important session; for the engineers present (and there were some very distinguished ones) showed not only that they are concerned about Canada's tendency to lean very heavily on the strong shoulder of her American neighbor, but also that they are resolved to do something about it.

Is this country facing the kind of future which will have little or no time for creativity? J. D. Orr, consulting engineer and one of two official speakers who led the meeting thinks the answer is "yes"—if the present trend continues.

"I can see the time coming," he said, "when there may be nothing creative left for us to do. And this could happen within 15 years. Then none of our young men will entertain the idea of becoming design engineers in Canada — which means we shall have lost all hope of regaining control."

He thought that the trouble lies in our eagerness to depend on U. S. design. "It is impossible to be creative without developing your own products. And we are very timid about doing this. We lean so much on U. S. ideas that there is just no opportunity left for creative thinking. It is no wonder that we lose so many of our younger engineers. There is no challenge, no excitement, no fun left for them in Canadian engineering."

Looking ahead, the speaker saw the position as getting much worse. "It is amazing to me," he said, "that there is a feeling of complacency among many engineers who think we are as good as the Americans. Maybe we are right now, but unless the present trend can be checked, we won't be. Design engineers need experience—and there is going to be none of the right kind available to us soon.

"This is going to affect our schools too, because they have to produce the kind of graduate industry wants. If there is no demand for creative engineers they will stop producing them. Even now our universities are teaching less creativity than you find in the U. S."

The speaker explained that creative engineering is the best way to win back independence. If engineers could convince management throughout industry that Canada could produce better designed products for her own and foreign markets at competitive cost, the problem would begin to disappear.

He explained that creativity is a science —a broad and exciting one. "Creative engineering is not a new term for a new field," he said. "Ever since man emerged from the jungles, there have been rare individuals who were able to bring forth new ideas that would better solve the

Continued on page 58

Below, all the engineers who met. For editorial comment, turn to page 82.

From left: J. S. Collins, J. F. Moore, L. G. McIntosh, F. G. East, Paul Dilworth, J. D. Orr, D. F. MacRae, A. Barrie, G. Southwell, E. H. Orr, B. A. Avery.

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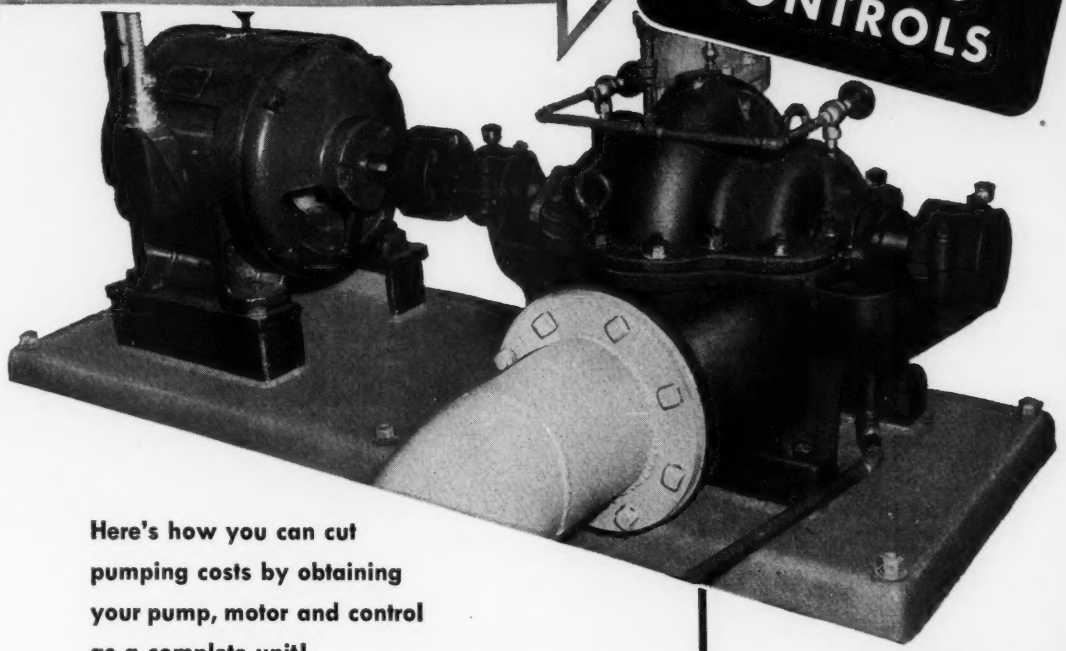

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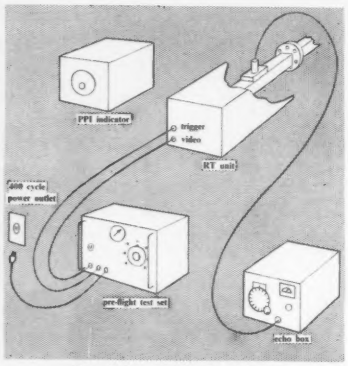
New Narda equipment enables pre-flight and front line radar checking by relatively inexperienced communications maintenance personnel. This development, according to the company, is significant due to a recent increase in airborne weather radar installations by the major commercial airlines.

Small, light and rugged for convenience and dependability, even under the most adverse pre-flight and front-line



Narda's pre-flight test set

conditions, the test set operates from the 400 cycle power available in the aircraft.

The set is used in conjunction with the company's 833 Echo Box, a high Q resonant cavity tuned to the radar frequency and coupled to the radar transmission line through the radar's directional coupler.

Here's how the test system operates. During the radar transmitted pulse, microwave energy is stored in the Echo Box. Immediately following the pulse, the energy is returned to the radar as from a target. The echo decays exponentially; the time interval between the beginning of the transmitted pulse and the point where the signal on the radar PPI scope just disappears (called the "ring time") is a measure of the radar.

Any decrease in transmitter power or loss of receiver sensitivity will shorten this ring time. Small changes in ring time caused by small departures from specified performance are resolved by the test set, without the complications of precise time base measuring equipment.

Although designed primarily for use with the echo box for testing C-Band Weather Radars, the pre-flight test set may readily be adapted with very slight modification to pre-flight or front-line checking of any radar, used with any good echo box tuned to the radar frequency. (200)

• • •

Latest trimmer potentiometer is introduced by technology corp.

LATEST IN THE complete line of TECHNOLOGY INSTRUMENT CORP. trimmer potentiometers, the RWT subminiature wire-wound device provides precise, stable voltage adjustment for compact assemblies, in a low-cost unit.

Electrically, the RWT provides an independent linearity of 5%, standard, and a 10% standard accuracy of total resistance. Low temperature coefficient of the resistance wire (amounting to 0.0017% per deg of C) contributes to the high electrical stability of the unit over a wide temperature range. Standard temperature range of the RWT is from —55 deg C to 95 deg C. Power rating for this diminutive trimmer is ½ watt at 30 deg C, derated linearly to 0.05 watt at 95 deg C for standard units. Units are available on special order for operation at higher temperature ranges. A wide range of standard resistance values are available in the RWT from 50 ohms to 15,000 ohms.

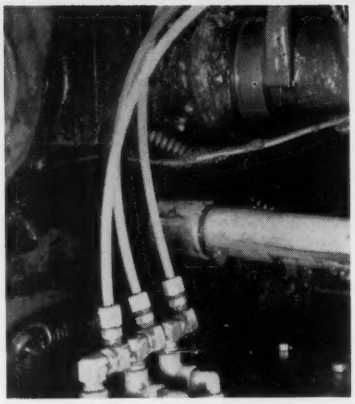
Especially applicable where space is at a premium, ten RWT units occupy less than one cu in. of space.

There is compact design in the internal construction also, with the result that the unique wiper-assembly and resistance-elements design permits use of the full resistance range. The dual-wiper sliding contact gives low-noise operation even when the unit is vibrated constantly. A 25-turn stainless steel lead screw, which is used to position the sliding contact, makes precise, stable adjustment. (201)

• • •

Nylon pressure tubing eases copper

A NEW SPECIALLY processed nylon pressure tubing, Nylaflow, is reported to have provided a material savings of 40% when replacing copper tubing in a convertible jet water system for shallow and deep wells made by the DEMING COMPANY. It is tough as well as cheap.



Nylaflow is used in a pump

This ¼-in. tubing with a burst rating of 1,000 psi is distributed by POLYPENCO, INC. It is used both as a pressure switch tube and an air control tube. These tubes are used essentially as "air lines," operating at pressures of approximately 40 psi. However, some condensation may collect in the tubing necessitating the natural corrosion resistance of nylon.

Deming has reported that Nylaflow was selected over other plastic tubing because of its high burst strength, resistance to vibrational fatigue, and its form stability which permits its successful use with standard compression fittings. The tubing's distinctive mechanical properties also played an important role in its selection, since it is abrasion resistant and resilient. It will maintain its original shape under an impact which would permanently dent metal tubing.

Nylaflow is considered rodent resistant as it is not relished by rats and mice as was the plastic previously tested. It is fungus resistant and inert to chemicals or corrosive atmosphere to which it would be subjected in actual operation.

Savings in installation time over the previously used metal tubings were also an important factor in its selection, since Nylaflow tubing requires no prebanding. It was simply cut on conventional shearing equipment and installed — no deburring was necessary. The tubing naturally assumed an attractive, symmetrical bend between connections. (203)

• • •

Inspect with a bench comparator

BOTH SKILLED and unskilled personnel may inspect parts quickly, accurately and dependably with a new bench model comparator just produced by the JERPBAK-BAYLESS COMPANY.

At the discretion of the operator, the comparator may be set to operate in a vertical, angular or horizontal position. Range capacity is from 0 in. to 6 in.

Simplicity of design makes it possible to market this comparator at a low price. (204)

Preparing to test a Company produced rocket-firing intervalometer at −65° F. at 60,000 feet altitude

A commercial environmental test lab in Canada!

One of Canada's first privately owned and commercially available environmental test laboratories is ready now—at your service. It is designed to test components and systems to military and commercial specifications. Here are two of the many test chambers. The left chamber tests at temperatures from −35° F. to 300° F., and at humidities from 20% to 98%. The right chamber provides temperatures from −100° F. to 300° F., at altitudes from sea level to 100,000 feet. If you have a qualification testing problem write for information on this new service to Canadian industry. Quotations are available on request.

Qualification testing for your products and research problems to current MIL Specs.:

- low temperature
- high temperature
- altitude
- humidity
- shock
- vibration
- salt spray
- sand and dust
- radio interference
- explosion
- fungus
- wind-tunnel

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New Products

(Continued from page 56)

AN AIR METER recently marketed by the HASTINGS INSTRUMENT CO. has been recommended by a major city's air pollution agency for use in smog control studies. It is a highly accurate instrument for measuring minute air flow movements and it is being used in connection with smog, air pollution and for other uses where extremely small air flow measurements are necessary.

With a range of 0-30 mph, and a logarithmic type meter scale which has expanded readings in the low velocity range, the company's Model R Air-Meter assures excellent readability below 5 mph and unusual accuracy below one mph. Response time is less than one second.

The air velocity measuring probe, which contains no moving parts to introduce friction or lag errors or maintenance problems, is horizontally non-directional and is suitable for portable use or for fixed installation. The probe may be installed at a remote point from the indicator. The instrument can be used with a recorder to obtain permanent chart records.

The unit uses the same patented noble metal thermopile principle used in Hastings highly sensitive, high-velocity Air Meters and Jet Vane, designed primarily for use by weather stations, airports, radio and television stations and for general meteorological use.

The company's air-meter indicator unit measures 4½ in. x 4¼ in. x 7½ in. and operates on 90-135 volts a-c, 60 cycle, with a 6-ft line cord. Battery-operated units can be supplied for field use where 110 volts a-c is not readily accessible.

The new meter can provide municipal and government health departments with a valuable instrument for study of their air movements in combating a problem of growing seriousness. (205)

• • •

Shallcross makes miniature switches

A COMPLETE line of low-cost miniature rotary switches for instruments, computers, RF switching, and other electric-electronic applications has been made by the SHALLCROSS MANUFACTURING COMPANY.

Known as the miniature series, the switches are designed in both shorting and non-shorting types with from one to four poles per deck and two to thirty-two positions per deck. Up to six decks may be ganged. A newly designed easily adjusted stop can limit switch rotation to less than the maximum number of positions.

Positive indexing, regardless of the number of decks used is provided by two stainles steel ball bearings held in a circular, flat, stainless steel spring. Torque is from 3 to 5 in.-lb for a single deck switch.

Designed for extremely compact equipment, the series measures only 1¾ in. square and has a back-panel depth of 1 in. for the first deck, plus ⅝ in. depth for each additional deck. (206)

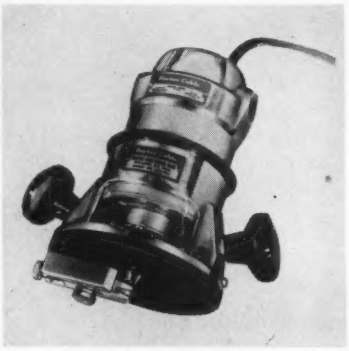
• • •

Plastic trimmed by new router

A NEW LOW-COST laminated plastics trimming kit and guide for a portable electric router, suitable for use by fabricators of Formica and other plastic materials simplifies flush and bevel trimming by eliminating tedious adjustment.

Produced by PORTER-CABLE MACHINE CO. and specifically designed for use with the Model 511 and Model 100 routers, this trimming kit permits accurate and simplified trimming of laminated plastics.

The kit extends the utility of the 511 router which is widely used by builders and woodworkers. The router has an



A new router for plastics

interchangeable motor that may be used with the power plane or a lock mortiser. The Model 511 is powered by a universal a-c - d-c motor which turns the split-type collet at 22,000 rpm.

The company's 100 router has an interchangeable motor which may also be used with a power plane in addition to a shaper.

The design of the plastic trimming bit and guide has overcome such problems as edge burring, bearing jamming and loss of adjustment which have plagued fabricators in the past. A single bit handles both level and flush trimming. Once the bit is centred over the roller, a locking screw guarantees that this adjustment does not change.

Only a depth change is necessary to change operations. Micrometer-type threads on the centring screw permits fine adjustment. Smooth rolling action of the nylon roller permits accurate trimming of edges. (207)

Engineers meet

(Continued from page 54)

problems which plagued them. This is what we need in Canada now. Instead, we are under tremendous pressure to conform. These are days of mass production, mass appeal, and mass markets and it is especially hard for Canada to think for herself. We find ourselves as a herd within a wandering herd wandering in whatever direction we are told."

Another speaker, Alexander Barrie, Managing Editor of **Design Engineering** magazine pointed out that since 1949, U. S. investment in Canada's industry has doubled and stands now at $10 billions. "There is a lot of talk going on about foreign domination of our industries," he said. "But I still wonder if people understand how serious it is."

We are 40% foreign owned

As examples he cited that out of 4,250 American companies in Canada, only 2% have Canadians on the Board. "This all adds up to the fact that 40% of our manufacturing industry is foreign owned," he went on. "And the position is getting steadily worse. Engineers are going to have to lead management by the hand to show that Canadian engineering can compete with its massive counterpart in the U. S. if we are to survive as a sovereign nation."

Among the engineers present were Paul Dilworth, "Father" of the Orenda engine; Burton Avery, Orenda's chief design engineer; Col. Don Macrae, director of Industrial Research Services at the Ontario Research Foundation; and Frank East, Manager of the Hamilton Gear and Machine Company.

Speaking from the floor, Paul Dilworth said, "There is a lack of understanding by everyone, and by management in particular, of the jeopardy we stand in by depending on technological development in the U. S. This can only be put right by the continuing efforts of people like this group."

It was decided that another meeting should be held to discuss the formation of an official body as the best way of starting the fight to win back control of Canadian industry. No date for this second meeting has yet been fixed. But it is expected to be soon. And it seems probable that when it concludes, a new group will have been formed to play a big part in Canada's uncertain industrial future. ★

SPECIAL NOTE. Readers interested in the idea of more creativity in industry, are invited to send their names to Design Engineering. The editors will be happy to put them in touch with the organizers of the coming meeting.

Now... a belt with
IDEAL TROUGHABILITY

Goodyear Rayon Conveyor Belts for High Tension, Long Center Duty

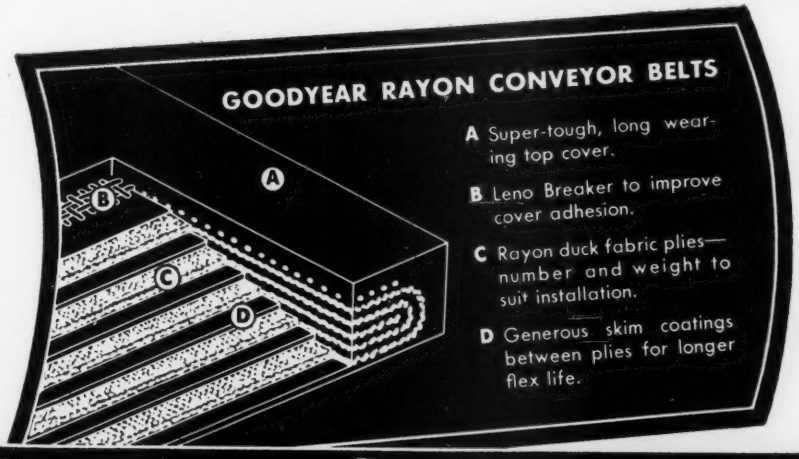
IDEAL TROUGHABILITY results from a flexible rayon carcass that is 30% thinner and 37% lighter than standard fabrics of equal strength. In addition, Goodyear Rayon Conveyor Belting "stays-put" with less belt wander, less edge wear and requires less driving power.

BALANCED CONSTRUCTION . . . rayon duck fabric has proper balance of length-wise and cross cords . . . assuring uniform distribution of load and consequently longer belt life.

SINEWY STRENGTH and FLEXIBILITY are combined in Goodyear Rayon Conveyor Belting . . . to withstand the gruelling grind . . . to carry more . . . to reduce costs on high-tension, long-center "carries".

TESTED AND PROVEN . . . more than 100 miles of Goodyear Rayon Conveyor Belting is in operation.

MORE TONS ARE MOVED ON GOODYEAR BELTS THAN ON ANY OTHER KIND


GOODYEAR RAYON CONVEYOR BELTS
A Super-tough, long wearing top cover.
B Leno Breaker to improve cover adhesion.
C Rayon duck fabric plies—number and weight to suit installation.
D Generous skim coatings between plies for longer flex life.
A
B
C
D

50 YEARS OF BUILDING CONVEYOR BELTS— Goodyear belting is used on the world's longest single flight installation—highest slope lifts and on most of the multi-mile conveyor systems.

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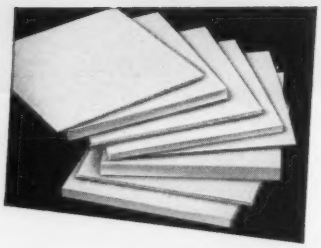
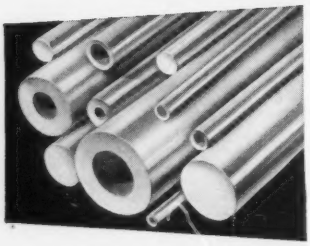
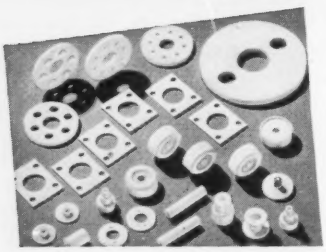
TUBING....MOLDED OR MACHINED PARTS?

YOU CAN GET JUST WHAT YOU WANT







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"*Made of Teflon by JOHN CRANE*" has become practically a standard specification for parts and components subject to severe electrical, corrosive, thermal, mechanical or atmospheric abuse. Whatever your requirements in Teflon . . . sheet, rod, tubing, packings, gaskets, bellows, insulators, sealing discs or non-stick parts . . . "John Crane" can supply them!

In addition, you get these important *plus* factors: complete uniformity throughout, high density control, freedom from flaws and rigid adherence to your specifications.

"John Crane's" complete fabrication facilities assure you prompt delivery on *exactly* what you want —no compromise. If you have an entirely new requirement, no standard design or procedure— "John Crane's" laboratory facilities, know-how, research and engineering experience go to work on *your particular* need.

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—300°F. to +500°F.

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LOWEST COEFFICIENT OF FRICTION

ABSOLUTELY NON-STICK

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Letters

Readers' viewpoints . . .

● Your article on the gas-turbine car (DESIGN ENGINEERING, March) was one of the best technical articles I have read in a long time. Your magazine is setting a new standard (new in Canada, anyway) for writing up difficult subjects. I have done a little technical writing myself—maybe I will send you a manuscript some day—and I know how hard it is to say difficult things in an interesting way.

Naturally, not all your articles have the same standard. But some of them have been outstanding and I think your magazine is getting better all the time. Mr. Biggar certainly did a fine job on the car of tomorrow. It is an example other magazines might try to follow. Keep going like this and you'll do all right.

Montreal. JOHN HUNTER

That cartoon . . .

● The other day one of our members showed us one of the cartoons that appeared in DESIGN ENGINEERING of October 1955.

The members of our association would get quite a chuckle over the new type of flying secretarial chair—so we are writing to ask permission to use this cartoon and send it to our members and prospective members.

Description of the drawing is a picture of an executive seated on the left with a beautiful secretary taking off in a helicopter chair.

Your fine co-operation would be appreciated . . .

Chicago J. R. MIDDLETON, *National Office Furniture Assoc.*

Permission happily granted.—Ed.

Can readers help?

● You ran an article on epoxy resins (DESIGN ENGINEERING, November) and seemed to indicate that, perhaps, a clear resin of this type had been or was close to being developed.

I wonder if you would be good enough to tell me whether this is so and, if it is, who is manufacturing it and who is the Canadian representative.

I am trying to find a clear, hard varnish that will spray or paint on maps, will adhere very strongly, will be flexible, will air-dry and will not affect the printers' ink used on the average map. From

your article it would appear that one of these resins might be my answer. I shall appreciate any help you can give me on this subject.

F. W. PERCIVAL
Research Director,
Toronto. *MacLaren Advertising Ltd.*

Epoxies are not an answer to this sort of problem yet. They are not clear enough. Acrylic emulsions seem a better bet—perhaps Rhoplex AC 33 or Acryloid B 72 would give the protection with clarity. If readers have any better suggestions and would care to send them along, they will be passed on to reader Percival.—Ed.

Back copies wanted

● It would be very much appreciated and helpful to me if a copy of the article "How can you best heat treat aluminum" (DESIGN ENGINEERING, November and March) could be sent to me.

LAWRENCE I. CHASEN
Pennsylvania *Vertol Aircraft Corp.*

● Will you please send three copies of the article, "Facelifting for an electric motor," (DESIGN ENGINEERING, February) by A. J. Girdwood.

This article provides a very interesting and informative description of a new motor development, including the problems and the method of approach to solve them.

This type of article is useful to all connected with design work and contributes to the excellence of DESIGN ENGINEERING.

B. F. NEWMAN
Motor Engineer,
Toronto. *Wagner Electric*

Separate copies of the article are not available. However, a free copy of the February issue has been sent to motor engineer Newman. Other copies can be bought at the single-copy price of $1.00.—Ed.

● If it is still possible to have three copies of the first issue of DESIGN ENGINEERING I should like to have them sent to me. I am interested in the article "Could Canada's jet engine be simpler than this?"

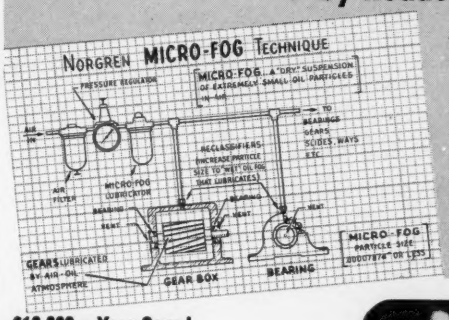
If you keep back copies, perhaps you would attend to this as soon as possible. Thank you.

DESIGN ENGINEERING does keep back copies but finds they run out in the end. None of the few April copies left can now be spared except on an "on-loan" basis. If reader Quiller would like to borrow one, this can be arranged.—Ed.

How NORGREN MICRO-FOG Lubrication is INCREASING MACHINE and TOOL LIFE

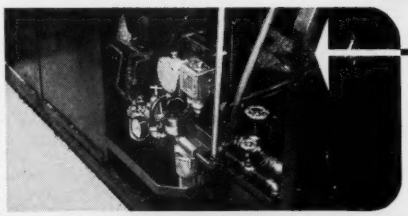
by Reducing Wear on

- BEARINGS
- GEARS
- CHAINS
- CAMS
- TAPS
- DIES
- Other Tools and Machine Parts



$13,000 a Year Saved on One Machine

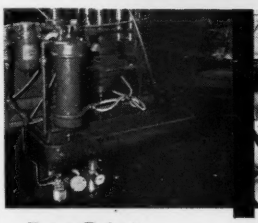
Pump recirculating system lubricating chasers on this tapping machine was replaced by Norgren MICRO-FOG. Results: $13,000 a year saved by eliminating the cost of degreasing parts; tool life increased 300%.



8 Drops of Oil Per Minute Lubricate Machine

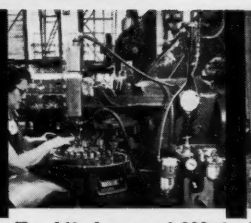
All parts of this automatic screw machine are lubricated by MICRO-FOG. Results:

- Increased life of bronze slide blocks and other parts.
- ½ pt. of oil per day does better lubrication job than 15 gal. did previously.



Fewer Rejects

Mill and power heads packed in grease heated excessively after only one hour operation, causing inaccuracies in milling; MICRO-FOG lubrication has ended the overheating. The number of rejects has been substantially reduced.



Tap Life Increased 300%

MICRO-FOG lubricated 6 taps on this tapping machine, replacing a pump recirculating system. Results:

- Big Savings in lubricant.
- Tap life increased 300%.
- Tap breakage greatly reduced.

Cam and Bearing Wear Cut on Printing Presses

Conversion of six printing presses to MICRO-FOG Lubrication resulted in the following:

- Ended flaking and galling of cam parts.
- Stopped heating and excessive wear of bearings.
- Eliminated daily manual lubrication.

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File

New booklets and books written for you

LITERATURE ON NEW steel grit blast cleaning abrasive has been published by the WHEELABRATOR CORP. This abrasive, called Steeletts, is intended for producing etched finishes on metal.

Available in seven sizes, it is particularly suited for providing a deep etch on metallic surfaces for bonding. On coatings of enamel, paint, glass, rubber, plastics, plating and metallizing it readily clings to the etched surface.

It will provide lustre on non-ferrous work by exposing virgin metal and giving it a matte-type finish.

Descaling alloy forgings and heat treated work is another feature. It can be used for etching steel mill rolls where its high hardness and great impact will penetrate, giving a deep, long-lasting etch.

Although the abrasive has high hardness, it also has long life because the particles are free from brittle carbides that cause rapid breakdown. (208)

• • •

Bulletin describes new mold powder

A "MOLY" FILLED nylon molding powder, trademarked Nylatron GS is described in a new bulletin available from POLYPENCO, INC.

The bulletin explains how the field for molded nylon applications is expanded due to the superior wear and frictional properties of Nylatron GS, along with its resistance to heat distortion and expansion. Test data are included.

The compounded powders are reported to be readily moldable in equipment used for standard types of nylon. (209)

• • •

Visi-Trol conveymatic is unveiled

THE DEVELOPMENT of the Conveymatic, a heavy-duty, synchro-precision platen conveyor has been covered in a brochure from VISI-TROL ENGINEERING COMPANY. Conveymatic standard model platen conveyors are available in lengths up to 100 ft. Company engineers say that special models can be produced beyond 100 ft, to specified lengths. In general, conveymatics can be lengthened in 10-ft multiples in accordance with production operations and changes.

The standard Conveymatic platen conveyor models are said to include jig-drilled interchangeable 10-ft sections; 36-in., 38-in. or 40-in. working heights; 12-in.-long steel platens, each providing 12½-in.-wide working area; 4,000 lb. chain pull; continuous variable speed range from 100 ft to 300 ft per hour. Other features include an overload cut-out clutch; lubricated ways and bearings; start-stop-reverse push button control panel meeting all JIC standards; right or left-hand offset drive, as specified; parts pan support rail; stationery or index fixtures, as required.

Optional features of Visi-trol platen conveyor (furnished as specified) are an in-line or vertical drive; automatic lubrication; intermittent or index motion; special speed ranges. Specified lengths, heights, widths and speed ranges and arrangements for automatic indexing of fixtures are other features.

Conveymatic platen conveyors lend themselves to precise synchronization for integrated operations. They are completely adaptable to automation lines and initial and replacement tooling can be installed rapidly at a minimum cost.

The publication says the company will engineer, fabricate and install tooling and other mechanisms related to the Conveymatic, thus delivering a complete package installation. (210)

• • •

Aluminum folder has real samples

A FOLDER ENTITLED "Alcan Embossed Pattern Aluminum Sheet" showing actual samples of the embossed patterns has been published by the ALUMINUM CO. OF CANADA.

Five attractive embossed patterns add to aluminum's ever-growing usefulness and versatility. They also enhance the natural attractive appearance of the metal. Embossing also stiffens the sheet and minimizes dents and blemishes which might occur during installation.

The company's embossed patterns can be used in many general ways. (211)

• • •

Publish list of tubes, components

A NEW FOLDER which gives a partial listing of their tubes and components has been published by BOMAC LABORATORIES INC. Included are specifications for TR, ATR, Pre-TR and attenuator tubes, special shorted TR and ATR tubes, dual and triple TR and ATR tubes, pressurizing windows, spark gap tubes, surge protectors, silicon diodes mangnetrons, reference cavities, shutter tubes, klystrons, hydrogen theyratrons and traveling wave amplifier tubes.

Also included are representative pictures of different types of tubes, and a brief description of Bomac's service to the electronics industry. (212)

Book Department

Atomic Energy and its Application

THE GREAT advances of the past ten years in nuclear physics have produced new techniques with useful applications in almost every branch of science, medicine and industry.

The achievements and potentialities of this branch of applied science are well-known among the present generation of atomic physicists, but the relevant information is not often available in publications readily accessible to those trained and employed in other specialties.

This book, Atomic Energy and its Applications by J. M. A. LENIHAN has been written to provide a simple account of the physical foundations of nuclear science, a concise description of their applications and a guide to future progress in the exploitation of atomic energy.

After an introductory summary of current ideas on atomic structure, X-rays and radioactivity are discussed from an experimental standpoint. Chapter 4 deals with nuclear stability and binding energy, providing a foundation for subsequent enquiry into the fission process. There follows a description of methods used for the detection of nuclear radiation by ionization chambers, Geiger-Muller counters and other devices. High energy physics is next discussed, Chapter 6 being devoted to particle accelerators and Chapter 7 to consideration of the nuclear reaction initiated by energetic particles.

One particularly important class of nuclear reaction—the fission process—has a chapter to itself, thus completing the first section of the book. The various applications of atomic physics are then taken up and the three succeeding chapters deal with nuclear reactors used for the release of energy and the production of radioactive material. The atomic bomb is a nuclear reactor of a special kind and an account of its technical aspects occupies Chapter 10.

The reader is assumed to have modest scientific attainments, including a knowledge of physics to the standard of the ordinary degree or the Intermediate B.Sc. Those who only want to know something of the application of nuclear physics to their own subjects should, however, find this information.

The book covers a very wide field and consequently is bound to skimp certain aspects of the subject. However, it is a very useful book to have on the library shelf for reference purposes. One mistake that was spotted appears on Page 4, where it states that the atomic number (z) of argon is 20. Actually this is 18. In addition, it is felt that Table 25, which gives details of some reactors, would have been better if the code names and numbers had been quoted throughout. The book is published by Pitman and Sons (Canada) Ltd. Price $4.50.

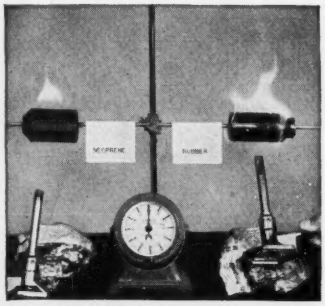
using

DU PONT ELASTOMERS

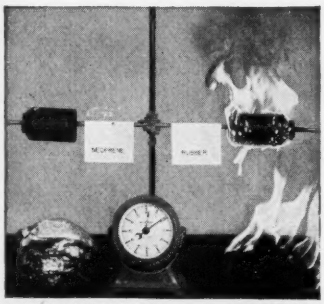
NEOPRENE - HYPALON

in Design

NEOPRENE ROLLERS PASS FLAME TEST!



PRINTING ROLLERS of neoprene (left) and natural rubber (right) are exposed to the flame of Bunsen burners until they ignite.



IN FIVE SECONDS after burners are removed flame on neoprene roller is out. After 69 seconds, drippings from flaming rubber roller have ignited newspaper.

This test convinced management of the New York *Daily News* that neoprene printing rollers offer an extra measure of safety over natural rubber. Today, they flame test all rollers before they buy—and neoprene rollers are the only rollers that meet the test.

Neoprene's resistance to flame may well be useful to you as an added safety factor in your product designs. And neoprene offers resistance to abrasion, oil, heat, and chemicals as well. For all general-purpose applications, you can count on neoprene for long-term service. Clip coupon for further information.

Resilient gaskets of HYPALON unaffected by 2% ozone

Re-usable after 2 years in ozone generators

For two years now Emery Industries has been using HYPALON synthetic rubber gaskets to seal its ozone generators. The company's ozone-producing installation is the largest in the country. Its operations supervisor, Robert Peters, made this report on HYPALON. "No failures with HYPALON gaskets in two years, even though they've been exposed to 2% ozone."

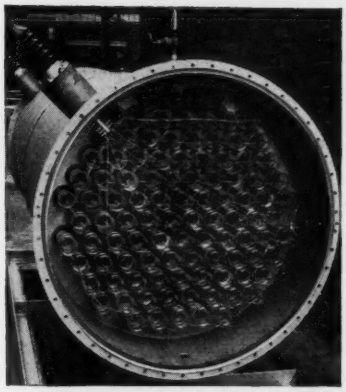


Photo courtesy Welsbach Corp., Phila., Penna.

HYPALON gasket on ozone generator showed no sign of deterioration after two years of service.

Design of the generator

The generator used by Emery Industries consists of a steel shell packed with a series of glass tubes individually encased in an electrically charged metal enclosure. A conductor carries an opposing charge through the glass tubes to make, in effect, a large electrical condenser. Dry oxygen is passed along the length of the glass tubes and converted to ozone. The generators are closed at each end by a dished head sealed with HYPALON gaskets.

HYPALON replaces plastic

Formerly, plastic gaskets were used in the generator. While unaffected by ozone, plastic gaskets had to be replaced after each maintenance checkup because they were too rigid for re-use. HYPALON gaskets, even after two years of service, retain their resilience and are still re-usable. Says the generator manufacturer, Welsbach Corporation, in Philadelphia: "We use HYPALON gaskets because they have the best over-all combination of properties of any we've found—including ozone inertness, resilience and cost."

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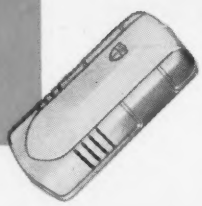
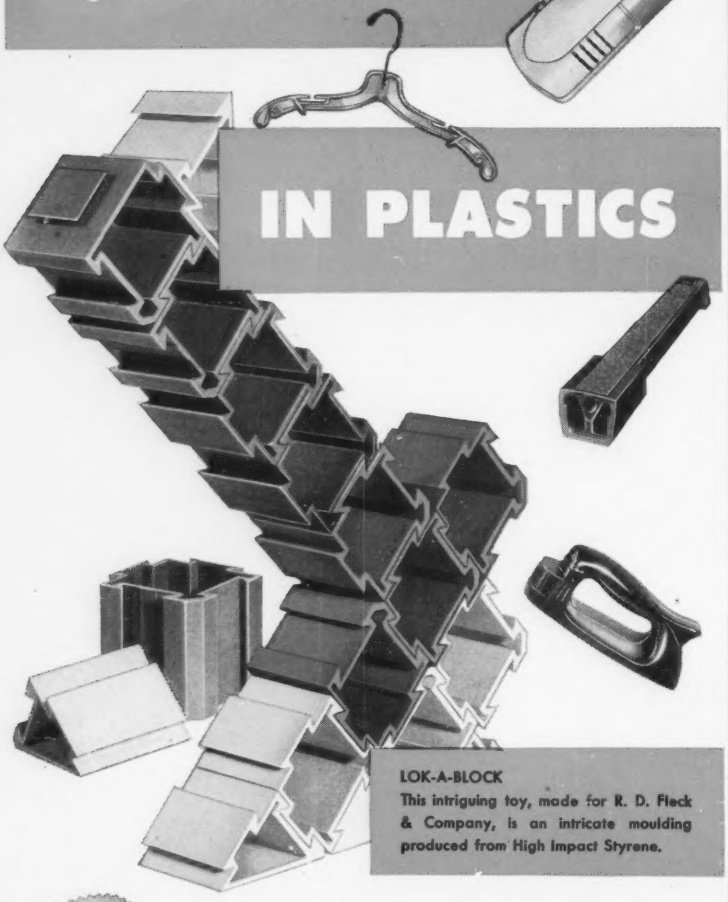
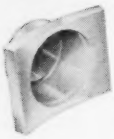
Pacemakers



IN PLASTICS



LOK-A-BLOCK
This intriguing toy, made for R. D. Fleck & Company, is an intricate moulding produced from High Impact Styrene.



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Flowcoating

(Continued from page 39)

head was in position and all welding equipment had been removed. Under these circumstances the fact that the change was completed in five days can be considered very satisfactory. It was possible only through careful planning and excellent team work.

Throughout the planning stages, hourly rated personnel directly affected were kept fully informed of plans and developments. This has contributed considerably to the effectiveness of the new system.

The co-operation of the departmental foremen was of course essential, and many initial errors were avoided as the result of their advice in the planning and execution of the project. The quality control department co-operated with the paint suppliers in developing the new materials and the purchasing and stock control departments ensured the timely change of stocks of paint.

An hour by hour schedule

A heavy responsibility rested on plant engineering and the instructions to nine outside contractors and equipment manufacturers had to be closely dovetailed. These instructions included an hour-by-hour schedule for the entire five-day period of the installation. The schedule specified the time and sequence in which each contractor was to complete the various tasks assigned to him. This was to ensure that work would follow the best sequence and to limit mutual obstruction to a minimum.

As good drainage is of paramount importance, some modifications in the design of parts were necessary. The engineering, tool design and production control departments had to ensure that the old designs had passed the paint stage and new designs were available as soon as the new system was ready for operation. Special carrier or paint hooks had to be made and spray painters had to be trained the new way but less than two months after the first item was flow-coated, the division stepped up production to a point which would not have been possible unless the new system had been introduced. ★

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Quotes

'Must find cheap alloys' — turbine expert

NEW ALLOYS for automotive turbines is the subject of an SAE paper by DONALD N. FREY.

In order to establish the gas turbine as an automotive powerplant, whole new classes of high temperature alloys will have to be developed.

The necessity for new alloys for the automotive gas turbine arises almost exclusively from considerations of cost. High temperature alloys used by aircraft turbine builders would be largely satisfactory for the contemplated stresses and temperatures in automotive turbines, except that they are too costly.

This paper should be considered as a progress report on new alloys for automotive turbines. Large scale commercial production of most of the materials described has not been accomplished. Also, the amount of operating experience to date on automotive turbines is so limited that material development is largely incomplete.

A table shows a breakdown of weights for a hypothetical regenerative gas turbine of 300 hp. Also shown are estimated upper limits of alloy costs for the various categories. The costs are only approximate, but were established with some regard for the alloy composition that will probably serve the purpose, and at production volumes large enough to minimize the price.

• • •

CMA summarizes fatigue tests

FATIGUE UNDER Traxial Stress and development of a testing machine are summarized by MORRISON CROSSLAND AND PARRY in the Chartered Mechanical Engineer for March 1956.

The behaviour of materials subjected to steadily increasing stress is, in an engineering sense, fairly well understood; and testing under systems of triaxial stress, in particular systems in which varying degrees of triaxial tension or compression have been added to shear stresses, has contributed much to this understanding.

In fatigue testing, on the other hand, failure almost invariably starts under biaxial stress at a free surface, and information as to the strength of materials under repeated applications of triaxial stress is almost completely lacking. It would seem that such information might be most valuable in promoting a better understanding of the whole nature of fatigue failure.

The thick cylinder subjected to repeated internal pressure is an instance of considerable practical importance in which such stresses occur, and many failures of such components are on record which are difficult to explain on the basis of the known fatigue properties of the material used. For both academic and practical reasons, therefore, it seemed that experimental work on the behaviour of such members might very well be rewarding.

Some few experiments on this topic have been carried out in the past, but these have essentially involved very low speeds of testing and have, therefore, been confined to the upper end of the mortal range.

The practical problems in building satisfactory experimental equipment to run at a sufficiently high pressure and speed are considerable. Not without difficulty, such a testing machine has been designed, built and developed to a satisfactory degree of reliability; and, in the hope that the experience gained may be of value to others interested in the problem, a large fraction of the paper is devoted to its description.

• • •

Aluminum-tin alloys will distort Lack stress strength in soft condition

THE BONDING of aluminum-tin alloys to steel was dealt with in the Quarterly Journal (No. 32) of the Tin Research Institute.

If full advantage of the bearing properties of the aluminum-tin alloys containing 20% or more of tin is to be obtained, they should be used in as soft a condition as possible. However, in the softest condition the alloys lack the strength necessary to withstand the stresses which arise in use and the distortion which follows may lead to bad fit and ultimately to failure.

The successful application of the high-tin alloys therefore depends to a large extent upon finding means of bonding them to strong backs, preferably of steel. The means of achieving this have been studied in considerable detail and methods of producing bonds of adequate strength have been developed by rolling together aluminum-tin alloy and aluminized steel.

In early experiments, it was found that with alloys containing more than 10% tin, a loss of tin occurred when bonding was carried out at a temperature above 230 C. This loss is due to the tin-rich constituent, which melts at 228.3 C, being squeezed out during the rolling operation. The loss of tin is somewhat variable, but increases in bearings of higher tin content.

The residual tin content after rolling is also variable but may be as low as 7% for alloys which initially contain 20% or more tin. This difficulty has made it imperative to carry out the bonding operations at temperatures below the melting point of tin.

Bonding direct to clean steel was found to be very difficult, although occasionally good bonds have been obtained. More reliable results have been obtained by bonding the aluminum-tin alloy to "aluminized" steel.

• • •

Military, civilian uses grow Canadian transistor market booming

DETAILS OF ELECTRONIC equipment using transistors are given in an RCA VICTOR—ELECTRONIC NEWSLETTER which states that electronic equipment fitted with Canadian-made transistors may soon be available in quantity for the first time.

The story of the transistor (see Design Engineering, May 1955) already being manufactured for research and testing at their Montreal plant, is one of the brightest of the electronic age.

Manufacturers of hearing aids started substituting it for the vacuum tube three or four years ago. Now the switchover is practically complete, and hearing aids which fit into a vest pocket, a purse or even a hair-do, have become the standard kind.

The same thing is starting to happen this year in other lines. Several pocket-size, all-transistor radios have appeared on the market in recent months. A larger, "personal size" portable sets, designed for very long battery life, are now available.

Meantime, leading electronics conconcerns are already gearing for one of the next big markets which transistors are headed for: car radios. are expected to run on about the same amount of power needed for the two dial lights in today's sets, and it has been predicted that this change-over will be completed within a few years if plans go as they are scheduled.

While the civilian market is starting to snowball, military demand for transistors is growing fast.

In computers, guided missiles and communications equipment for defense, they save on power and space. For instance, one computer capable of handling 100,000 single-digit sums per second needs only a quarter the power and one-seventh the space of older-type models. And the steadily growing share of aircraft electronic equipment—radio, radar, navigation aids and so on—which is being built with transistors, is bringing precious weight savings in engines and airframes. Undoubtedly uses will increase as time goes on.

Compressed Air Clutch
operated by .....
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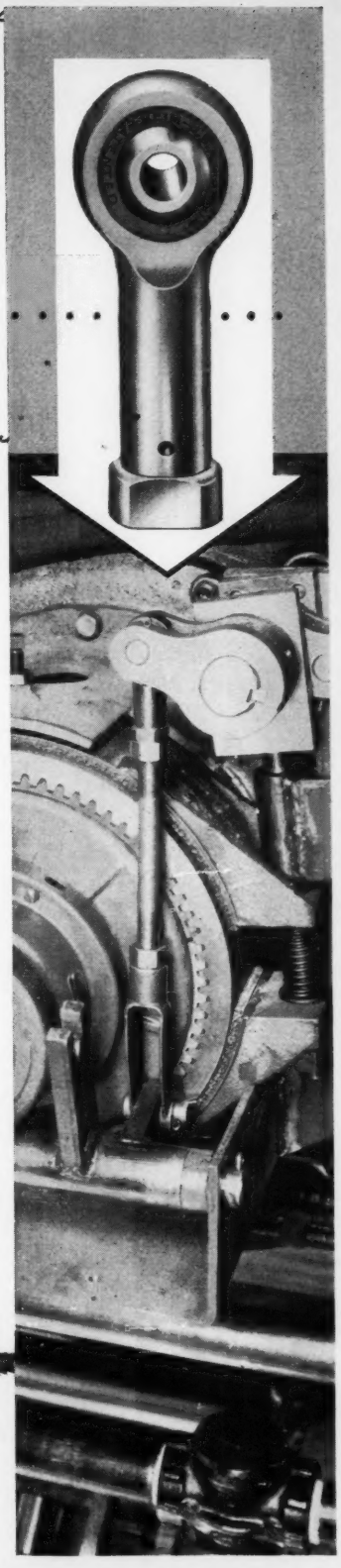

On the Joy Champion Blast Hole Drill, there is a compressed air operated clutch which is used for tramming a machine with special wide crawler treads used on the soft ground in strip mines operations. A heavy duty, self-aligning HEIM Rod End transmits the motion through the linkage operating this clutch.

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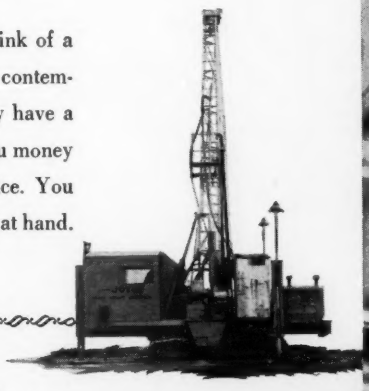
Whether your product perches on the brink of a strip mine or is one of the thousands of contemporary tools and machines, you probably have a place where a Heim Rod End can save you money or deliver smoother, longer-lasting service. You should at least have the new Heim catalog at hand.



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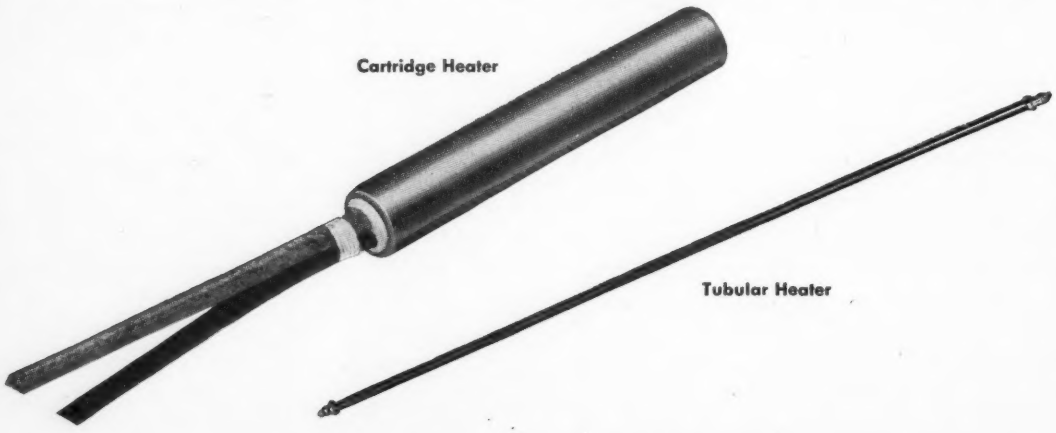

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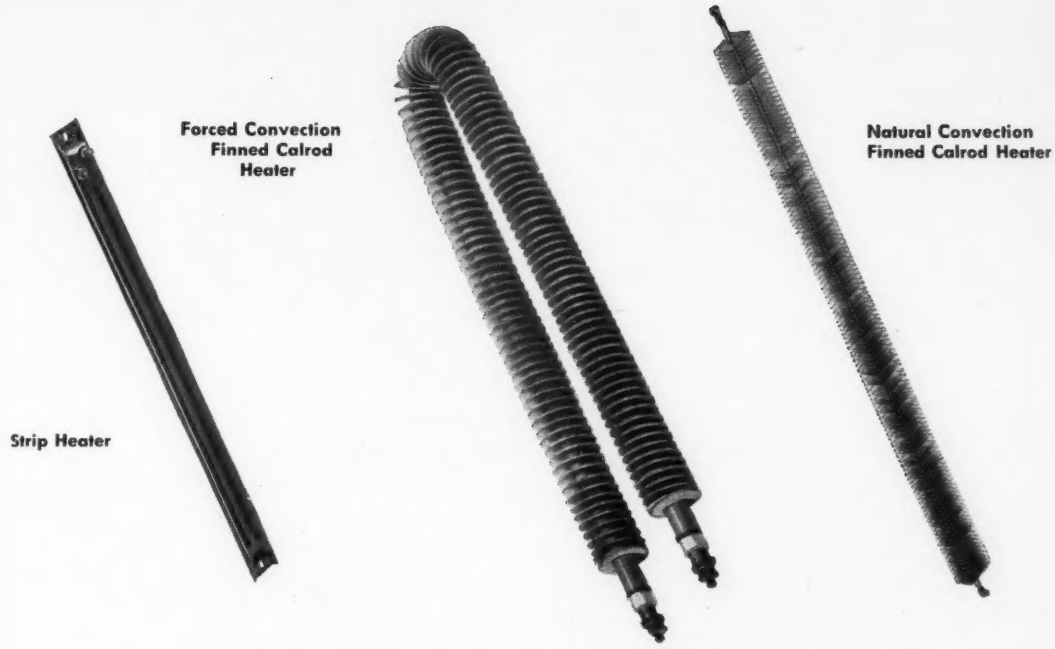

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Patents

New way to bond metal to bearing shells

BETTER BONDING of metal coatings on bearing shells and similar objects is said to be the advantage of a new method described in Canadian Patent 519,228, which was issued on December 6, 1955, to Metallizing Engineering Co. of New York.

Invented by Arthur P. Shepherd of New York, the new method depends on the application of a thin coating of molten molybdenum onto the article before the main coating of molten bearing or other metal is sprayed on.

• • •

Improve washing action in washer

A DEVICE to improve the washing action of washing machines by keeping the wash totally immersed in water is the subject of Canadian Patent 519,124 issued to the inventor, John Wurmlinger of Dunkirk, Sask., on December 6, 1955.

The invention involves placing a flat disc on top of the wash. The disc is slightly smaller than the inside diameter of the tub and has a number of shallow blisters on its surface to make it more buoyant by trapping air bubbles.

• • •

Devise new rotor for aero turbine

A NEW KIND of rotor for gas turbine aircraft engines is the subject of Rolls-Royce Limited Canadian Patent 523,517 issued April 3, 1956. Invented by three British inventors, the rotor has a continuous metal outer shell, which forms the inner wall of the passage for the working fluid.

The desired number of rotor discs are enclosed within the shell, and have the usual blade slots to receive the ends of the rotor blades.

The peripheries of the discs are brazed to the shell for greater strength. From the slots the blades project through apertures in the shell into the working fluid.

• • •

Ont. inventor has disposable mat

A DOOR MAT that is disposable is the subject of Canadian Patent 523,346 issued on April 3, 1956, to Bruce W. Borgstrom, of Clarkson, Ontario, the inventor.

The door mat consists of a paper sheet that will absorb moisture, with a waterproof coating on the underside of the sheet. If the sheets are to be used individually, a sheet of burlap or other reinforcing material that will prevent slipping on the floor is fastened to the underside of the waterproof coating. The sheets may be made up as a pad so that removal of the soiled one at the top of the pad exposes a clean sheet.

• • •

G.M. patents method to rapid-cure

RAPID CURING of sand-resin molds for use in shell casting is covered by Canadian Patent 523,457, issued April 3, 1956, to General Motors Corporation.

The patent describes the method as involving heating the metal pattern to a temperature between 250 deg F and 600 deg F, applying the sand-resin mixture until the resin is melted and then, after removing excess sand-resin mixture, exposing the outer surface of the melted layer to a temperature of 800 deg F to 1,600 deg F for not more than sixty seconds before removing the mold from the pattern.

The inventor is Alfred L. Boegehold, of Detroit, Michigan.

• • •

A. V. Roe improves vaporizer tubes

THE PROBLEM in aircraft gas turbine engines of achieving complete contact between airfuel mixtures and the walls of the vaporizing tubes has been dealt with by an improved vaporizer tube system which is the subject of Canadian Patent 521,769 issued February 14, 1956 to A. V. Roe Canada Limited, of Malton, Ontario.

Insufficient "scrubbing" of the walls of the vaporizer tubes may occur where the tubes first extend downstream and then extend transversely across the combustion chamber to a central nozzle. The change in direction throws the fuel-air mixture against the downstream, cooler side of the tube while the hotter upstream side is left dry and is quickly deteriorated by the heat.

Invented by Francis H. Keast and Frederick D. M. Williams of Weston, Ontario, the vaporizer tube system in the patent puts the downstream-extending parts of the tubes in the outer, cooler region of the combustion chamber. They extend more than normally downstream so that they can return upstream before crossing to the nozzle in central part of the chamber.

Thus the air-fuel mixture travels upstream before changing direction to cross the hot portion of the chamber, and the air-fuel mixture is thrown on the hotter upstream sides of the tubes rather than on the downstream sides, which do not suffer from the problem of heat-deterioration.

• • •

Apparatus prints the printed circuit

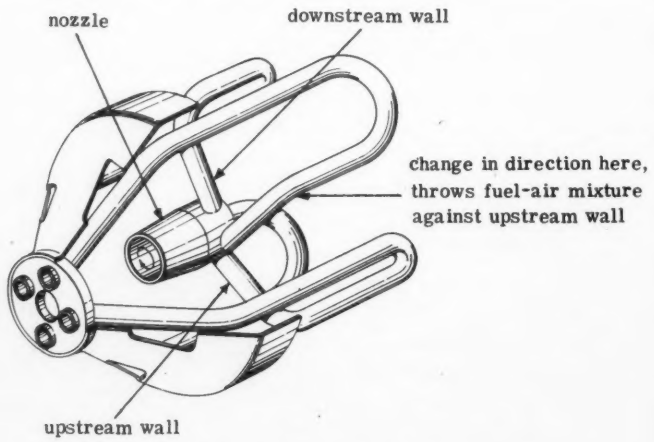
AN APPARATUS for printing electric circuit elements on a supporting base, which has a stencil overlying the base, is covered in Canadian Patent 523,968 issued to the Erie Resistor Corp., Erie, Penn.

The stencil has openings whose edges are in a sealing arrangement with the base. This design makes it possible to define the right area of the elements.

There is a means in the invention of injecting paint of the proper electrical properties into the cavities of the filling positions of the plate. There is also a way to vent the cavities through the stencil openings in the venting position of the plate.

The stencil is made of flexible gasket material that will accommodate the surface irregularities of the base.

The inventor is Jerome D. Heibel, Erie, Pennsylvania.



AVRO's improved vaporizer tube for gas turbine

Friction Materials

(Continued from page 51)

of the brake lining and brake drum at the point of contact during operation. But there is evidence (from physical testing laboratories) to show that temperatures from 900 F to 1,100 F are commonplace. Sometimes the part of the brake drum in contact with the brake lining reaches such high temperatures that the metal approaches a plastic phase and the drum metal "smears." Temperatures high enough to cause color changes are common.

Considerations other than heat dissipation often make a compromise on brake size and construction necessary. A brake drum large enough to dissipate the heat adequately is often not in proportion to the machinery on which it is used. The brake designer's word is law, because he must fit the brake and clutch mechanisms into the space available on the complete machine. It is up to the lining maker then, to come up with a product that will do the job.

There are many new fields for friction material manufacturers to conquer. The advances in air transportation pose some intricate problems. Aircraft landing speeds and loads are increasing, yet airfields are not getting much longer—which means quick stops are needed. Military aircraft with jet engines give a forecast of what must be met when jet engines power commercial aircraft on a large scale.

And surface transportation is faster. Brakes are now being called for which will stop automobiles from 100 mph in allowable distances with frequent applications of the brakes.

A brake lining is often asked, not merely to stop something but to decelerate it within close limits. Such an application is found on a centrifuge used in the sugar industry to separate various components. Thermoid compounded a brake material which caused the machine to stop at a constant rate. Too quick a stop would throw out the wrong component and too slow a stop would mean a poor separation.

Another tough application is found in the paper industry. As a large roll of paper unwinds, the roll rotates faster as the minimum diameter of the roll is approached. A brake lining had to be supplied that would keep the tension constant and prevent the roll spinning too fast as small diameter was approached.

Oil wells are going deeper and the load on brakes in drilling equipment is heavier. The deeper the well, the longer and heavier the pipe that must be hoisted each time the bit is changed. The brakes on the winches must hold to prevent thousands of feet of pipe from dropping

Continued over page

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into the well. Gear tooth clutch facings on the winches raise the pipe.

An unusual use of a friction material for a non-friction application is found on high-speed passenger railroad cars. Excessive wear and noise occurred at the area of contact between the car and its trucks when metal plates were used. So a friction material is being used that stops the noise and also contributes to riding comfort by eliminating excessive movement between car and trucks. Not only is the friction material cheaper but it outlasts the metal plates used previously.

Modular design

(Continued from page 47)

These circuits are further complicated since extra package terminals are provided at circuit junctions likely to require multiple connection. In the case of taper pins, each input or output lead consumes one terminal.

Another approach to modular design of computers is to contrive standard circuit connection patterns that accept a variety of components and interconnections within the module itself.

This method was rejected a year ago on the basis that it gave the designer unlimited flexibility: It could not conceivably lead to more than standardization of the circuit pattern itself. It is a sound approach if the designer wishes merely to increase production in order to justify the use of printed circuits. However, replacement is sacrificed along with many other useful features.

Modular design can be put to work to reduce complication in digital equipment designed around the electron tube. And even greater opportunities exist in transistorized equipment.

It seems to be possible to combine one, two, three and four input series gates in virtually any combination within a module. In fact, if we are a bit short of flip flops in associated circuitry we can convert two of the gate sections into a flip flop.

These series gate sections can be used as parallel sections, wherever they are required as individual gates or in combinations as series parallel gates. The same applies for a parallel gate package.

If our logic consists of flip flops and gates in approximately equal proportions we can interconnect another of our standard packages consisting essentially of four flip flops; associated trigger sections; and elements of the gate package which suits our purpose.

Here we effectively increase the capacity of the gate package by using the trigger sections of the flip flops in series or parallel with appropriate sections in the gate package. Again if we require an extra flip flop and have spare gate sections in our assembly this can be connected on the gate board.

All well and good, but there are recent findings that temper this. We now know that we must add components to each of the gate sections appearing in the block diagram in the interest of extreme reliability. This means that we would reduce capacity of the packages shown by 20 or 25%. The flexibility of our circuit packages may be improved to a point; certainly it won't be impaired.

It is then apparent that modular design can be a useful tool; it offers opportunity to standardize circuits either within a machine without sacrificing design flexibility, or it offers opportunity for development of a completely mechanized approach to computer design and manufacture.

The concept of pre-packaged or off-the-shelf assembly of computer and data processing equipments is attractive. Meanwhile the promise of mechanization and simplification of a serious maintenance problem will justify our efforts.

How then does industry feel? In a statement made by M. R. Johnston of General Electric recently, he said: "The advent of modular design and mechanized assembly will make imperative an ever-increasing co-ordination and integration of design engineering and manufacturing engineering."

Most certainly our engineering designs, both mechanical and electrical, he said, will be greatly influenced by the automatic machines that will build and test them.

"On the other hand, the designers of automatic assembly machines and automatic test equipment must take into account the complexities and modern circuits. Mechanization and automation must not hamper, but rather permit and foster the continued rapid technological growth of the electronics art."

He said that no longer will it be feasible for engineering simply to design and manufacturing simply to build.

"We may pride ourselves on the co-operation and feedback we have between design engineering and manufacturing. Standardization will probably be the best man, if not the minister, at the wedding," he concluded. ★

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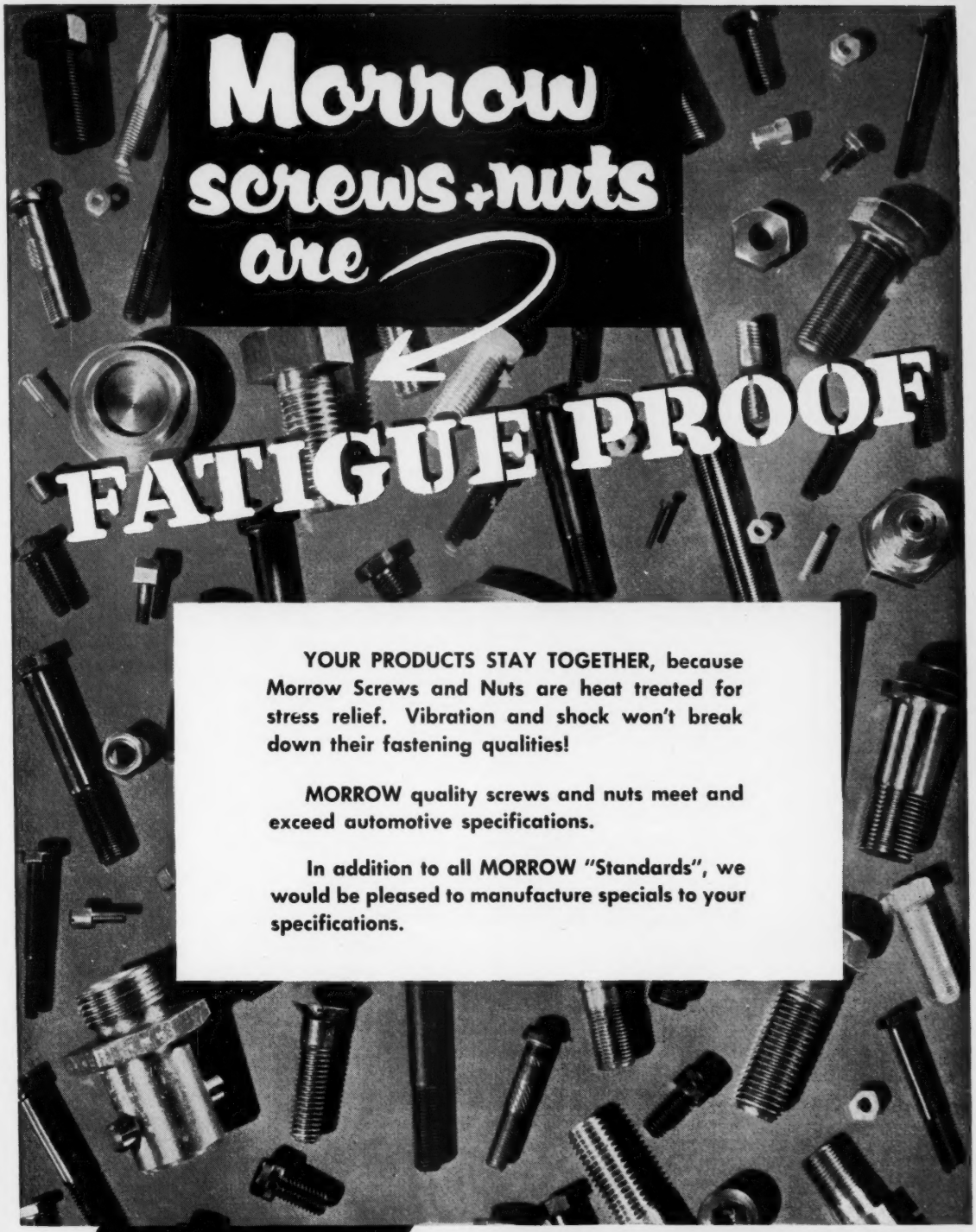

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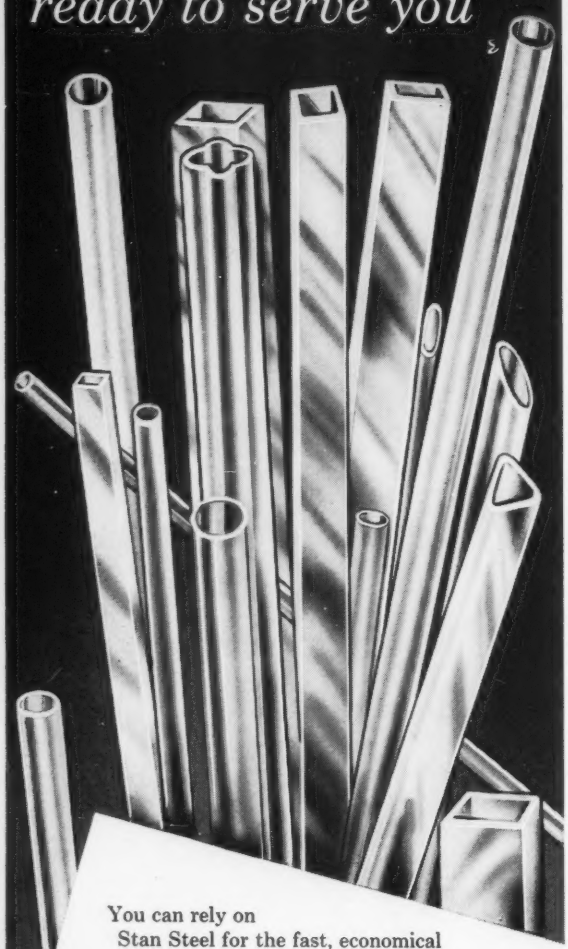

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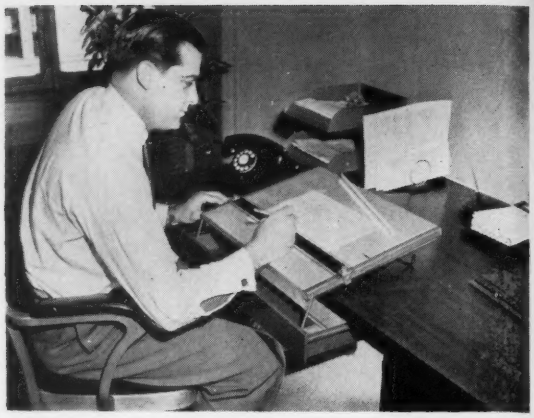


Ideal for the executive who must do some drawing, the board is fitted with all that is necessary to do work.

How can you draw at your desk? Perhaps

For executive engineers a new

A drawing board that folds away when it's not being used into a desk drawer—hmm! What engineer has not pondered and indeed sought such a device that could in effect be instantly tucked away in a centre drawer beneath a table or desk and brought out equally fast?

There is such a thing now and it is known as the Foldaway Drawing Board. It is the answer to the never-ending quest for more economical use of working space, designed particularly for executives and supervisory personnel who must on occasion do a little drawing or drafting.

Effectively providing extra foldaway space in places like premium-spaced studios and drafting rooms, it is also a boon to photo studios and dark rooms, print shops, art classrooms, as well as advertising and editorial offices.

The entire unit, manufactured by the Arnot-Jamestown division of Aetna Steel Products Corp., consists of a drawer, drawing board and parallel rule.

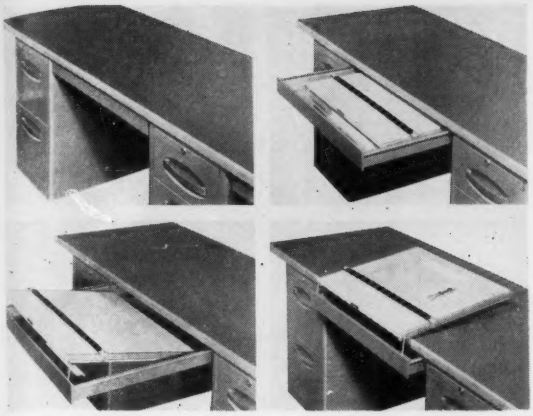
Remember May 14-17, date of

May brings more than sunshine to Canadian engineers. This is the month of the **Design Engineering Show.** All engineers who can find any way to escape for a day or two to Philadelphia's convention hall, are urged to do so.

Last month's issue carried a specially prepared invitation to all readers which will get you through the gate and into the Show without delay. Admission is free and probably no engineers anywhere in the world had such a promising educational chance offered at the expense of others.

Much attention is currently being given to Canada's struggle for the right to design and engineer her own products. Nothing is more important to the success of this move than the ability of her engineers to meet the challenge that goes with it.

Knowledge is on offer at Philadelphia. It is knowl-



Drawer is closed, top, and opens right to reveal drawing board which is pulled out and erected at bottom.

this simple idea is the answer you want

drawing board that tucks away

Primarily designed to go with the company's line of office furniture components, the unit can be easily bolted or screwed to any conventional desk or to a table-top.

Folded away, the board is completely out of sight. The entire unit looks like a regular centre drawer and leaves the desk or table-top completely free for other paper work.

Smooth drawer gliding is provided by self-contained suspension fixtures equipped with nylon. The drawing board itself is attached to the drawer by specially designed hinges. It moves into position easily on the desk top to give a comfortable working slope.

Designed in two sizes, the smaller unit has a 24-in. by 24-in. drawer with a 20-in. by 15-in. board. The larger unit has a 30-in. square drawer with a 26-in. by 21-in. board.

Available in three colors, the units sell for about $30. ★

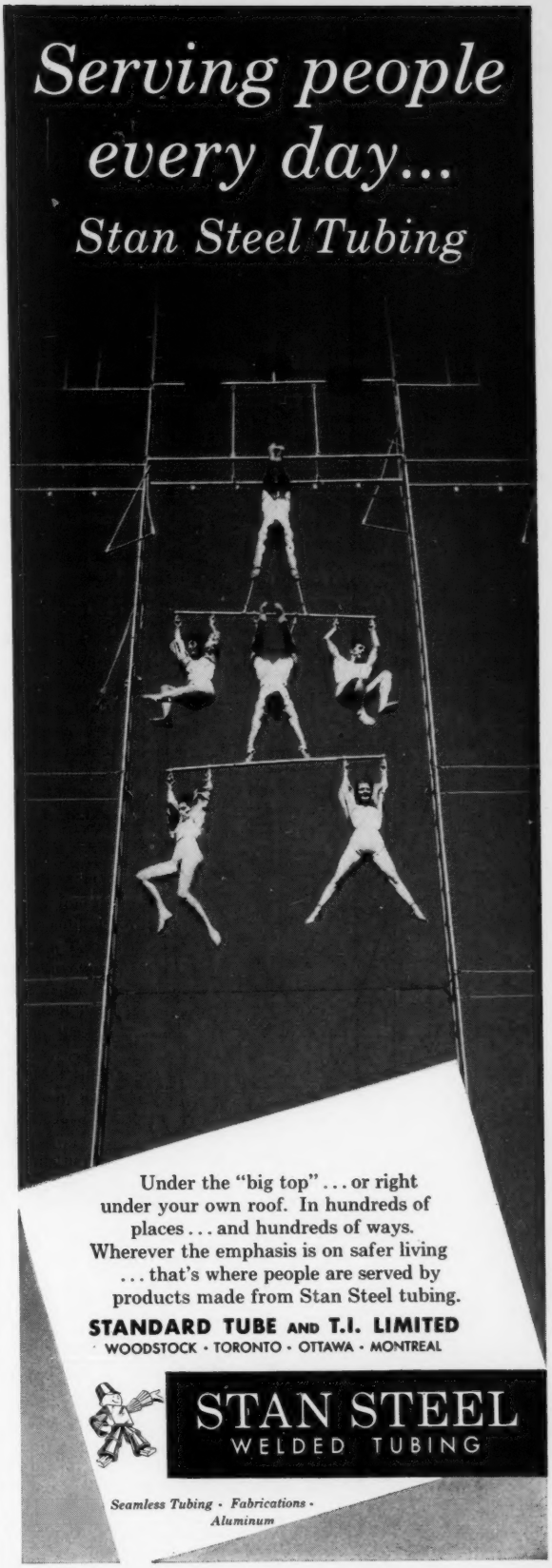
first design engineering show

edge that Canada needs. Every engineer who goes is better equipping himself for the competitive years that lie ahead.

Coinciding with the Show is an important conference called to study design engineering problems. Without doubt many of the world's best engineering brains will be in Philadelphia this month.

Over 200 manufacturers are expected to ship equipment and specialists for the benefit of all engineers. Few technical questions will go unanswered. Many problems hampering manufacturers today will be solved by discussion with the experts there to give whatever help they can.

The date is May 14 to 17. If it is not already on your desk diary, enter it now. Canada should be well represented at the biggest engineering show ever. ★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Mechanical heart

(Continued from page 43)

glass tube the blood absorbs part of the oxygen and gives off its carbon dioxide content to the excess of oxygen which is present.

The oxygen carrying the carbon dioxide is then drawn off into another spiral tube containing sodium hydroxide which absorbs the carbon dioxide. The purified oxygen is then pushed again into the hematosis spiral and more oxygen is added to replace that absorbed by the blood.

Some ozone is mixed with the oxygen to enable it to be more easily absorbed.

Throughout the pumping and hematosis devices, electronic controls keep the blood pressure equal to that of the body of the animal and adjust the supply of oxygen and ozone so that they do not upset this balance.

This simply is the basic design of a very bulky, very complicated, and equally expensive machine.

Dr. Tremblay says he does not know what the exact cost of such a machine would be if it were to be manufactured, as he hopes it will be, on a commercial basis.

"For me," he says, "it represents the culmination of six years of actual work and many more years of dreaming, thinking and planning—can you put a price on that many years?"

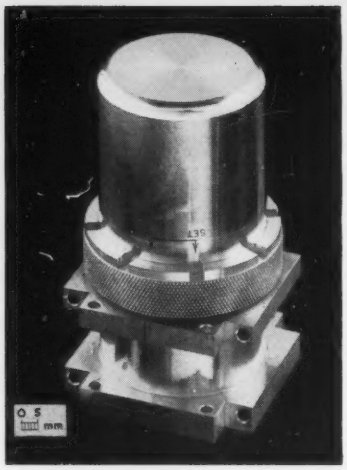
It is quite probable that engineering talent and professional designing will reduce the bulk and add to the efficiency of the "electro-magnetic heart and lung device for surgical purpose."

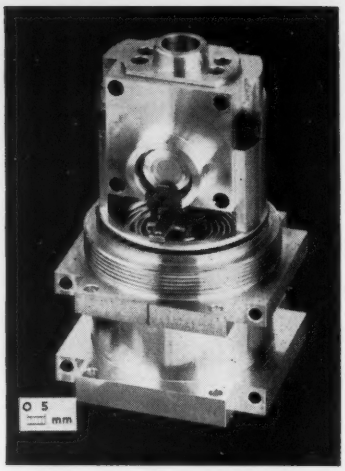
And its eventual price will, of course, depend upon the demand.

But if the device fulfils the hopes of its inventor and the surgeons and other medical men who have worked on it with him, the demand should be very substantial.

Heart disease is the greatest killer of modern times. But "disease" is not actually a good word for hearts damaged from birth or by a condition similar to that which afflicted President Eisenhower and affects many thousands of less famous people. Damage to the heart is mainly mechanical, caused by the difficulty of maintaining the normal blood flow into and out of the heart.

In recent years surgeons have been able to do a great deal to repair such damage and Dr. Tremblay's machine holds promise of enabling them to operate with greater safety and better results on patients who are now considered "operable" and to move into the "operable" category many patients who are now outside it. ★





The new $29 impact recorder. Picture on right shows its fused clockwork parts.

Tiny recorder will make aircraft safer

A NEW "crash recorder," costing only $29 has just been produced at the National Physical Laboratory, England. It will make flying safer.

The new instrument will record the story of aircraft crashes and enable aeronautical engineers to discover the forces applied to a plane at the moment of impact.

The instrument which, in fact, measures the retardation of a plane during the period of impact, is known, paradoxically, as an accelerometer. It will be carried in the plane and is designed so that it can do its job, survive the crash (and any subsequent fire) and preserve its record for inspection.

The Ministry of Supply intend to use the instrument for investigations into design for passenger safety and it is hoped that one or more will be fitted to many planes when they are built. Any plane unlucky enough to crash will then provide valuable data about its own destruction.

An instrument using the same principle could be used for the checking of the performance of space ships and artificial satellites if they were recoverable.

The instrument was developed at the request of the Ministry of Supply and its design brought up several problems.

It had to be able to measure retardation up to 50 g—50 times the acceleration due to gravity. (Human beings "black-out" at about 5 g.)

It also had to be able to remain in working condition for ever without attention, survive any possible crash and subsequent fire and be reasonably cheap to produce. In addition it was desirable that it should not be bulky or weigh more than 1 lb.

The requirements ruled out the use of photography, electricity and electronics and the instrument eventually produced was operated by a fuse-clockwork motor.

The motor operates immediately the retardation exceeds 5 g and rotates a small glass disc on which a fine layer of gold has been deposited. A weighted arm carries a stylus which, when the weight moves forward through inertia during the period of impact, scratches a trace on the layer of gold on the revolving disc. From this trace the forces involved can be calculated.

Performance and design data in brief is:

> Weight 1 lb 2 oz. Range 0-50 g. Accuracy ±5% limited to ±1 g. Undamped natural frequency, 100 c/s. Approximately critically damped. Response to 95% of step function in 0.01 sec. Record rotates when retardation exceeds 5 g, with time lag 0.017 sec. Rate of rotation of record, 3 sec per rev with time resolution to 0.017 sec. Low cross sensitivity. Resistant to effects of fire up to 400 deg C. Transit locking provided for both accelerometer and record motor. Airtight casing.

Static calibration of the instrument is made by deadweight loading of the movement.

The dynamic response is then found for an acceleration pulse using an electromechanical impulse apparatus. The accelerometer damping is then adjusted so that there is no overshoot for a quasi square wave acceleration pulse. The shortest pulse provided is at a 50 g maximum which is maintained within 5% for more than the specified response time of the accelerometer, 0.01 sec. ★

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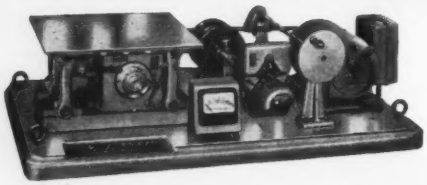

This machine, subjects parts or assemblies, up to 100 lbs. in weight, to a comprehensive vibration fatigue test. It has a 50% overload safety factor. Vibration in simple harmonic motion is produced horizontally. Displacement (double amplitude) is adjustable from 0" to 125". Automatic range Selector controls acceleration and deceleration. From 10 cycles per second frequency may be increased uniformly to 60 c.p.s. and then decreased to 10 c.p.s. Any desired range within the total may be selected. Selector can be switched off and frequency held at any c.p.s.

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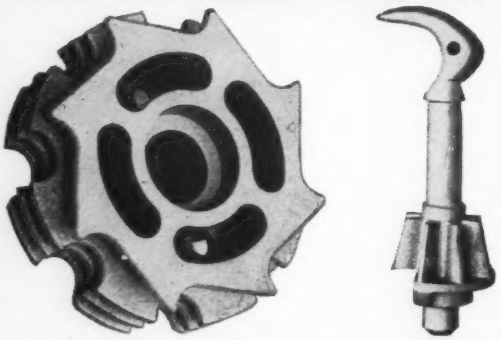

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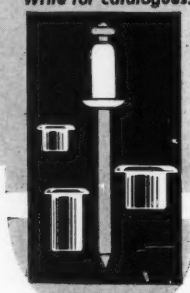

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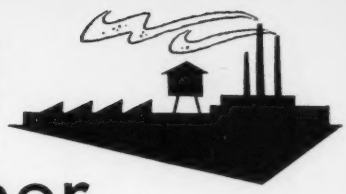

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Editorial

A special meeting warns of creativity crisis

AN EVENT took place a few days ago which may prove to be one of the most important single developments Canadian industry has seen for a long time. A special meeting of design engineers was called to discuss the problem of diminishing creativity and its Siamese twin, loss of control, that is threatening this country's future. A full report is carried on page 54.

Coinciding with the discussion came the news that Motorola Canada Ltd., is shutting down. Why is it doing so? Because the parent company in Chicago decided that it should. Here is a microcosm of the great Canadian picture. Too many executives south of the border (and elsewhere) are in a position to tell our industrialists what to do.

What can engineers hope to do about it all? There is a great deal they can do. The whole story of independence for Canadian manufacturers begins and ends with engineers, for two principal reasons.

FIRST, engineers are moving into the ranks of management at an increasing rate—and this movement seems likely to speed up as products grow more complex.

SECOND, it is the engineer's burden to show management what can be done and why it is proper to do it.

So it is good to hear that some of our engineers have taken the first step by facing the problems on a collective basis.

There were two official speakers at the meeting. Alexander Barrie, Managing Editor of DESIGN ENGINEERING began with an up-to-date report on Canada's present industrial position. Of the many facts he offered his listeners, perhaps two were outstanding for the grave note of warning they carried.

Out of 4,250 American companies in Canada, only 2% have any Canadians on the Board. And, as a result of heavy recent investment, foreign (mostly U. S.) interests now own 40% of our manufacturing industries.

"Engineers," he said, "are going to have to lead management by the hand to show that Canadian engineering can compete with its massive counterpart in the U. S."

J. D. Orr, of Orr Associates, followed with the only other formal speech of the session. He gave what might be called the definitive account of creativity—what it is and why we need it now. Then he threw the subject open to all comers. "It is up to you, gentlemen," he said, "to decide what we should do."

The response was immediate. Among the distinguished engineers present, not one stood back. Each showed his awareness of the problem; each agreed that it is engineers who have an immense job to do in steering Canada safely toward the independence she must have. And there was unanimous agreement that further meetings should be held.

Few will fail to see that creativity and economic independence go together. A country that loses its ability to create will have always to look for aid. It is not entitled to complain when it finds that aid carries a price tab. DESIGN ENGINEERING salutes the engineers now starting the fight for independence and hopes soon to report that progress is being made.

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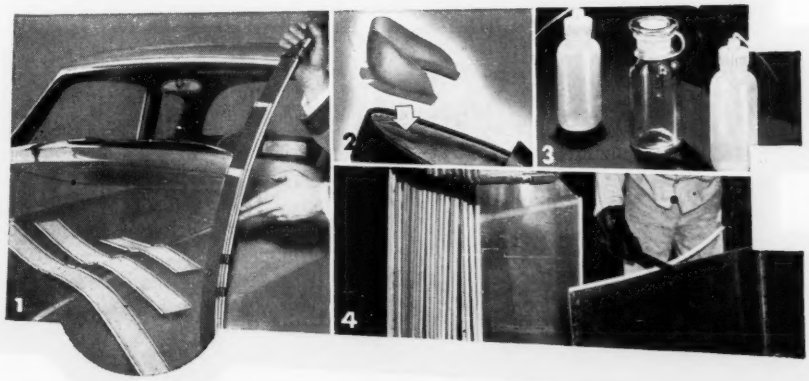

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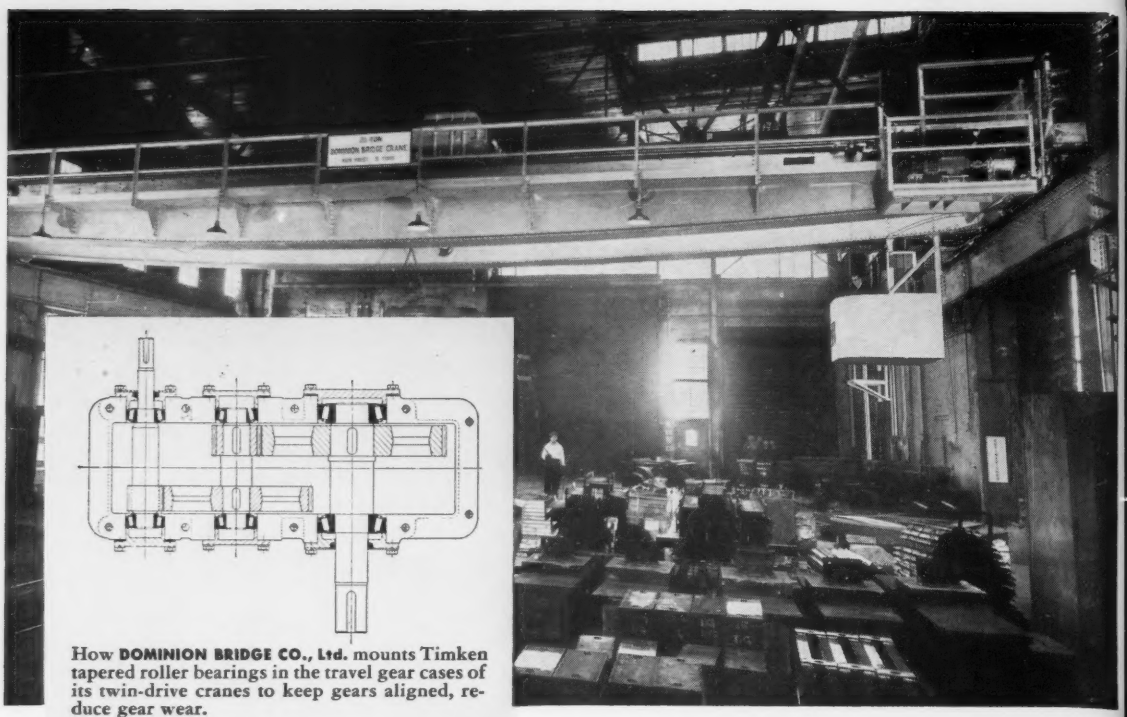

How **DOMINION BRIDGE CO., Ltd.** mounts Timken tapered roller bearings in the travel gear cases of its twin-drive cranes to keep gears aligned, reduce gear wear.

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...says Dominion Bridge Company, Ltd.

DOMINION Bridge Company, Ltd., Canada's oldest crane manufacturer, has relied on Timken tapered roller bearings for 27 years to keep its cranes operating efficiently, with minimum friction. In this 20-ton electric overhead travelling crane, for instance, Dominion Bridge engineers use 20 Timken bearings at vital points to take the heavy radial and thrust loads, keep the crane on the go.

Timken bearings provide extra load-carrying capacity because they have full line contact between rollers and races. And because Timken bearings are tapered, they take both radial and thrust loads in any combination. No extra thrust devices are needed.

Timken bearings practically eliminate friction because they're designed by geometrical law to have true rolling motion, and they're manufactured with microscopic accuracy to live up to their design, have a super-smooth surface finish. To further insure quality, we even make the steel that goes into Timken bearings.

Like Dominion Bridge Company, you'll find it to your advantage to specify Timken bearings in the equipment *you* build or buy. Look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. **CANADIAN PLANT:** St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN BEARING EQUIPPED — *This symbol on a product means its bearings are the best.*

TIMKEN *Made in* **CANADA**

TAPERED ROLLER BEARINGS

FOR CANADIAN INDUSTRY

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ▯ AND THRUST ←▯→ LOADS OR ANY COMBINATION ←✳→